Newport Research Facility

ANNUAL REPORT

NO. 60

Report for the year ended 31st December 2015

This report follows in sequence from the Annual Reports of the Salmon Research Agency of Ireland Inc. and the Salmon Research Trust of Ireland Inc.

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Summary

1. The Salmon Research Agency of Ireland merged with the Marine Institute on the 1st July 1999 into Aquaculture & Catchment Management Services and in 2010 the group merged with Fisheries Ecosystem Advisory Services. This report provides a continuation of the data records for the Burrishoole facilities.

2. The total rainfall recorded in Furnace in 2015 was 2011.8 mm. 2015 was the wettest year on record since 1977, with months of relatively high rainfall in January, November and December. Low rainfall was recorded in June, and October.

3. The environmental programme was maintained in the catchment with the network of rain gauges, water level recorders and river and lake monitoring stations all in operation. The end of 2015 was very wet, with several high floods in quick succession and exceptionally high water levels in Lough Feeagh in December 2015, resulting in considerable structural damage to MI facilitates, including the Black River AWQMS.

4. The total release of micro-tagged salmon smolts of Burrishoole reared origin into L. Furnace amounted to 34,458. Five tag groups (30,087), including one group treated with 'SLICE' for protection against lice infestation during early migration, were released into Lough Furnace on 30th April 2015. One tag group (4,371) was released in the estuary at Burrishoole Abbey on the same day.

5. In 2007, the Irish Government introduced a cessation of drift netting for salmon at sea and this was continued in 2015.

6. A total of 635 wild grilse and 4 previously spawned grilse (psg) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded was 11. The total run of wild grilse, including the Furnace rod catch (0), was 635 + 4 previously spawned grilse as determined by floy tag returns.

7. Returning adults were checked for net mark damage; 2.9% (n=622) of wild salmon (mainly in July) and 0.9% (n=1399) of reared salmon (in July) had net marks present.

8. The maximum spawning escapement was estimated to be 583 wild and 18 reared fish. The reared component was an estimate due to trap inundation during floods in November and December.

9. A total of 7034 wild salmon smolts were recorded in the downstream trap in 2015. The wild return of 2014 smolts as wild grilse in 2015 was 8.0%, an improvement from the 4.5% in 2014. The ova to smolt survival at 0.66 - 0.74%.

10. Wild kelt survival was 61.2% and tagged kelt return as previously spawned grilse later in the year was 2.7%.

11. The average return rate of the fish identified as Burrishoole core grilse was 4.3%. For comparison, the return rate of ranched grilse in recent years was 3.23% in 2014, 2.9% in 2013 and 4.89% in 2012.

12. A total of 59 wild sea trout and a further 79 non-silvered trout migrated upstream through the traps in 2015. Of the sea trout, 16 were adults and 43 (72.9%) were finnock.

13. The 2015 sea trout smolt run amounted to 426 smolts.

14. The percentage of trout smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1989 it collapsed to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's between 4 & 10%, rising to 16.7% in 1999. Finnock return in 2015 was 10.2%.

15. Silver eel trapping continued with the total run amounting to 1074 with the run spread over September, October and November. Big floods at the end of November and early December may have caused losses although these are through to have been low.

16. A total of 53 salmon were caught in the Rod Fishery in 2015. The catch consisted of 28 wild fish and 25 reared salmon. No wild fish were killed. The Lough Furnace rod catch consisted of 9 wild fish and 23 reared fish and the Lough Feeagh catch consisted of 19 wild fish and 2 reared fish. A total of 24 sea trout were caught on Lough Furnace and 30 sea trout on Lough Feeagh. Regulations remained in place whereby all rod caught sea trout were returned alive. In addition to the sea trout caught on Lough Feeagh, a total of 502 brown trout were also caught on the lough.

17. 2015 marked the completion of 25 years of catchment electrofishing surveys for juvenile salmonids and eel.

18. Eel fyke net surveys of Bunaveela, Feeagh and Furnace were undertaken in 2015 and quantitative enclosure net surveys were also conducted.

19. *Anguillicola crassus*, the non-native swim bladder parasite of eel, was recorded in the saline waters of Lough Furnace for the first time in 2011 each year since. Infection intensity has increased year on year. While it has now been found in small eels in the Mill Race channel, it has not been observed to date in eels from the catchment above the traps. This is the first known introduction of an aquatic invasive species into Burrishoole.

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1 Introduction

This report represents a continuation of the scientific aspects of the Annual Reports published by the Salmon Research Agency of Ireland, now integrated them into the Fisheries Ecosystem Advisory Services Group (FEAS) of the Marine Institute. The data presented creates a unique record of fish rearing and wild fish census data for the past 44 years. This data is an essential component in the local, regional and national management of salmon, sea trout and eel and is becoming ever more valuable in the light of increasing pressures on natural stocks, such as exploitation, habitat degradation and global climate change scenarios. The fish monitoring facilities in Newport, along with the reared and ranched salmon stocks held in Burrishoole, are also essential for the evaluation of novel enhancement techniques, alternative stocks and ranching and evaluation of interactions between farmed, ranched and wild strains.

2 Environmental Data

2.1 Mill Race Data

2.1.1 Rainfall

Daily meteorological data were collected during 2015 at the manual Met Station in Furnace. The monthly rainfall figures for 2012, 2013, 2014 and 2015 are given in Table 2.1, along with the annual totals for the years 1977 to 2015. 2015 was the wettest year on record since 1977, with months of relatively high rainfall in were January, November and December. Low rainfall was recorded in June, and October. The total rainfall was 2011.8mm in 2015. Daily rainfall amounts are shown in Figure 2.1.

Table 2-1: Monthly rainfall totals (mm) for the Furnace Station in 2012, 2013, 2014 and 2015 and the annual totals for 1977 to 2015.

Month	2012	2013	2014	2015	Year	Total	Year	Total
January	186.0	208.9	295.9	257.4	1977	1579.7	2000	1833.2
February	169.0	94.3	252.7	148.9	1978	1592.2	2001	1298.7
March	70.7	60.4	125.3	150.0	1979	1653.3	2002	1715.9
April	92.9	126.2	52.1	123.5	1980	1792.1	2003	1353.2
May	78.0	159.4	131.7	161.1	1981	1646.8	2004	1641.3
June	178.7	64.8	60.9	49.8	1982	1609.6	2005	1608.2
July	111.1	85.3	87.7	152.3	1983	1495.9	2006	1550.7
August	113.1	101.6	116.0	114.0	1984	1556.6	2007	1576.8
September	196.0	93.9	15.4	155.8	1985	1584.1	2008	1805.0
October	118.4	111.3	158.8	85.3	1986	1886.9	2009	1793.9
November	175.3	90.5	134.6	335.4	1987	1373.6	2010	1311.6
December	187.2	195.2	292.0	278.4	1988	1715.2	2011	1826.9
					1989	1583.9	2012	1676.4
Total	1676.4	1391.8	1723.1	2011.8	1993	1473.4	2013	1391.8
					1994	1757.1	2014	1723.1
					1995	1382.5	2015	2011.8
					1996	1286.6		
					1997	1351.6		
					1998	1830.9		
					1999	1949.1		

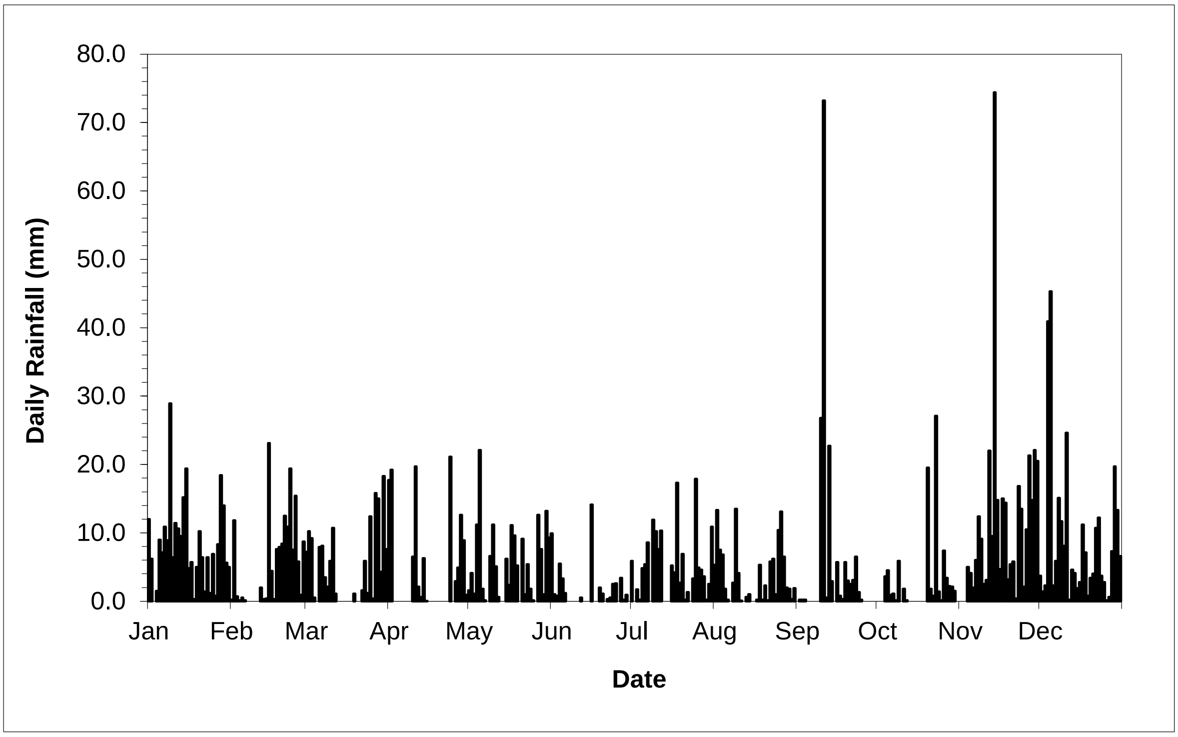


Figure 2-1: Daily rainfall amounts (mm) recorded in the Mill Race manual weather station in 2015.

2.1.2 Water Level and Temperature

Water Level: Difficulties were experienced in 2003 with the automatic water level chart recorder which had been in place since before 1970. An OTT Orphimedes automatic water level recorder was installed in late January 2004 and data from this sensor are presented here. Water levels are recorded every 15 minutes and are presented in Figure 2.2 recorded at 00:00 hrs.

The plot in Figure 2.2 shows a number of periods of low water, with drought periods in June-early July and late September-October. Three large floods occurred in September, November and December, the third one in December, associated with Storm Desmond, caused unprecedented flooding in the catchment and damage to the Mill Race river bed, weir and Salmon Leap Downstream trap channel.

Water Temperature: In 2004, a TidbiT temperature logger was installed along with the chart recorder and this records water temperature every 30 minutes. In 2009, this was upgraded to an OTT Orpheus mini sensor and logger. The temperature logger data are presented in Figure 2.3, recorded at midnight.

In 2015, water temperatures (recorded at midnight) fell to a minimum of 4.5^{0}C on the 4th February. There was then a fairly steady increase in temperature to a peak of 16.6^{0}C in mid-July, over two degrees cooler than 2014. There was a short peak in mid-April to 12.3^{0}C. The temperature dropped fairly steadily, but slowly, from early September for the rest of the year, to 7.7^{0}C at the end of December. The summer was cool, and the autumn and winter were unseasonably warm.

Note: A problem was encountered with the temperature TidBit data recorded from July 2010 to 2013. It was decided that the temperature data collected by the OTT Orpheus sensor at the same location was more reliable and the database will be updated accordingly. The 2015 data presented in this report was collected by the Orpheus sensor.

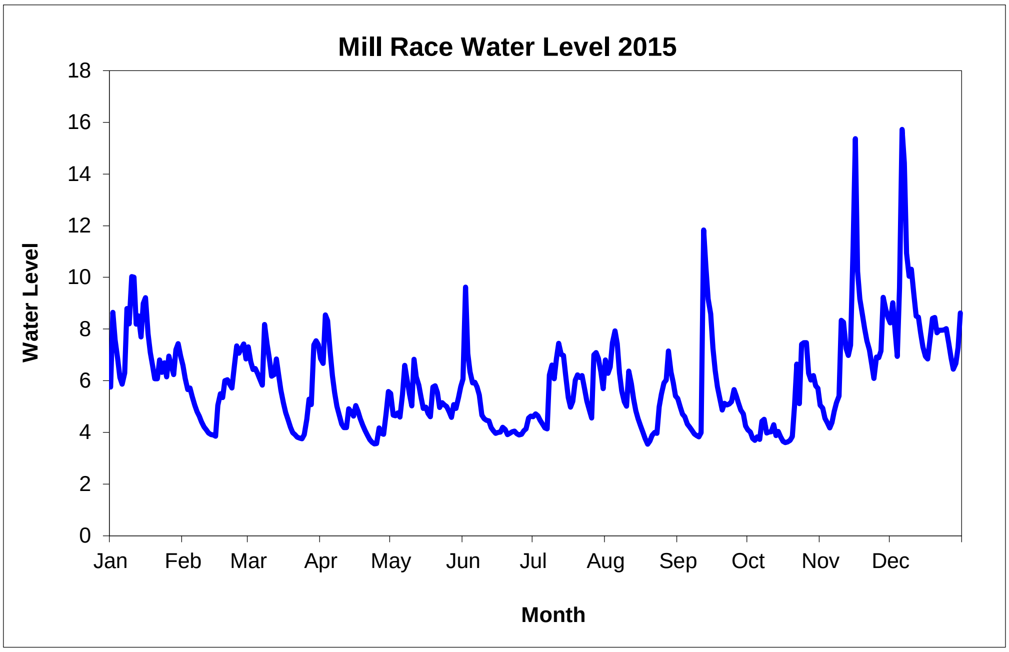


Figure 2-2: Water levels recorded at mid-night for the Mill Race using an OTT Orphimedes automatic water level recorder.

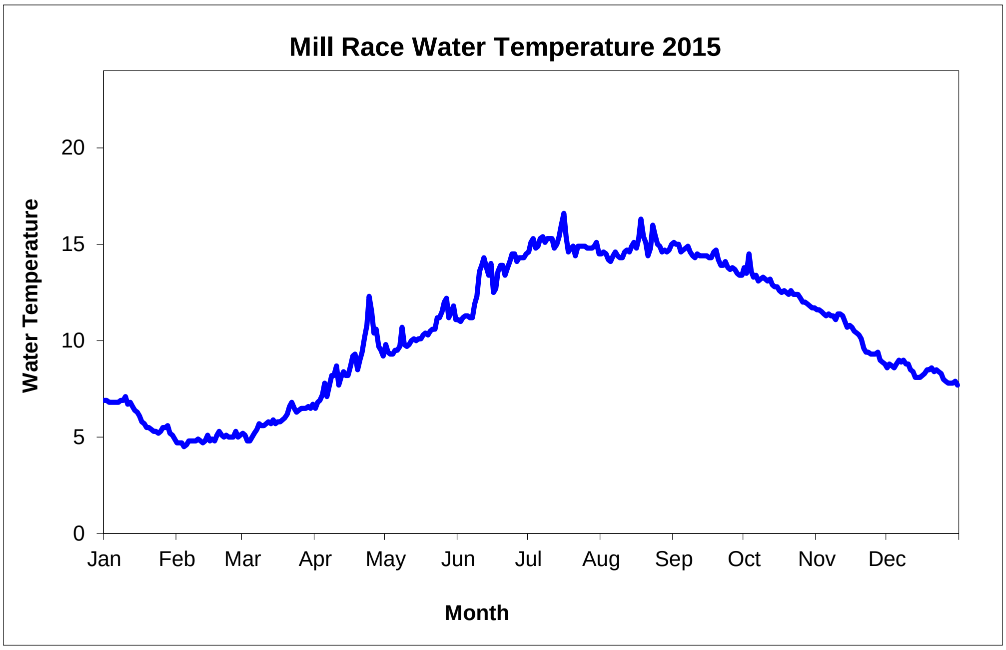


Figure 2-3: Water temperatures (°C) recorded, by OTT Orpheus mini sensor and logger, at mid-night for the Mill Race.

2.2 Catchment Programme

2.2.1 Background

Over the last twenty years, the Marine Institute has developed a monitoring programme in the Burrishoole catchment, with the aim of ensuring a long term ecological record against which changes in fish biology can be assessed. At the centre of the monitoring program are a series of automatic monitoring stations which measure key aquatic parameters at high frequency. These automatic stations include two lake stations (AWQMS), which have various meteorological instruments included with a suite of underwater temperature and water chemistry sensors, and three river stations, (ARMS), which are equipped with sensors for measuring water temperature, water level, pH, conductivity, dissolved oxygen, and turbidity. The automatic monitoring stations are also equipped with telemetry systems for relaying high-resolution data back to the laboratory. The data from the lake and river stations are complemented by spot samples analysed for water colour, turbidity, Total Phosphorus, Total Nitrogen and ethanol extracted chlorophyll *a*. In addition, the Institute has deployed core-funded instrumentation including temperature loggers, water level recorders and data-logging rain gauges in the Burrishoole, Owengarve and Owenduff catchments. These instruments allow high-resolution patterns of rainfall to be linked with stream flow. An important feature of the monitoring network is the ability to collect simultaneous data from river, lake, and climatic instruments.

In the last decade, the physical, chemical and meteorological data have been supplemented with biological datasets describing zooplankton and phytoplankton assemblages in Lough Feeagh and Lough Furnace, along with macroinvertebrate species occurrence and abundance from 16 index sites.

2.2.2 The 2015 Programme

The maintenance and development of long term physical, chemical and biological datasets characterising the freshwater component of the Burrishoole catchment continued in 2015. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites.

A number of intense rainfall periods and storm events took place in 2015, the most severe of which was Storm Desmond on the 4th and 5th December which led to unusually high water levels in Lough Feeagh and caused considerable damage to the Mill Race Channel.

2.2.3 The Black River

The main river flowing into Lough Feeagh is the Black River, also known as the Shramore River. A water level recorder is situated approximately 500m above the lake. Figure 2.4 shows the average daily water level for 2015 and Figure 2.5 shows the average monthly water levels from 2002 to 2015. The end of 2015 was very wet, with several high floods in quick succession. This resulted in exceptionally high water levels in Lough Feeagh, including a significant flood in December 2015, resulting in considerable structural damage to MI facilitates in Furnace (see also Figure 2.2 for the Feeagh outflow water level for comparison).

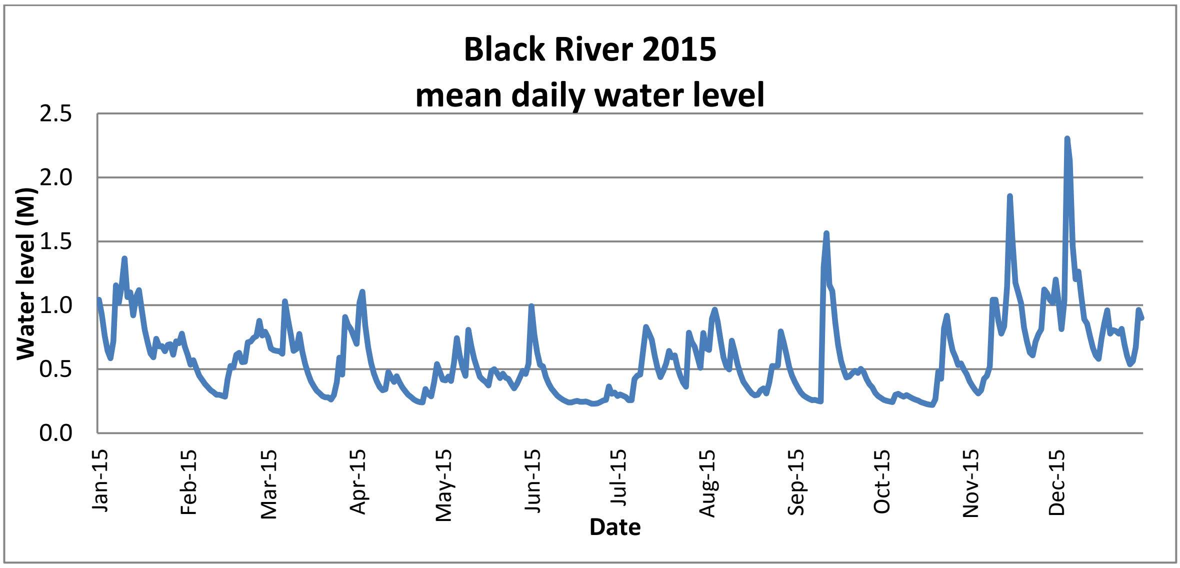


Figure 2-4: Mean daily water level for the Black River, 2015.

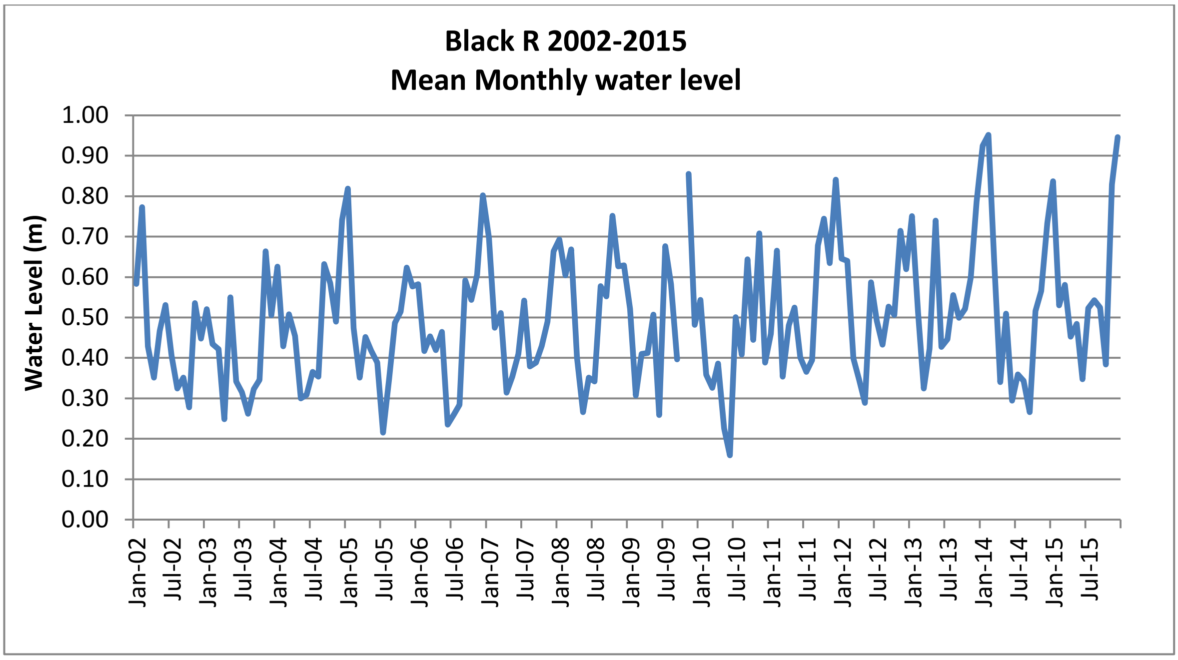


Figure 2-5: Monthly mean water levels for the Black River, 2002-2015.

2.2.4 Lough Feeagh

Lough Feeagh is situated in the Burrishoole catchment in the west of Ireland close to the Atlantic coast and is therefore strongly affected by the temperate oceanic climate that predominates in the region. The water is soft and highly coloured (2015 mean of 75 mgl^{-1} PtCo), and is oligotrophic, with Chlorophyll *a* ranging between 1 and 2µg l^{-1}. Mean annual Total Phosphorous is 7 µg l^{-1} (2013) and Total Nitrogen is 0.40mgl^{-1} (2013). The Lough Feeagh Automatic Water Quality Monitoring System (AWQMS) measures various parameters using a Hydrolab Datasonde 5, two

Chelsea Scientific Minitrackas and a Seapoint fluorometer (pH, dissolved oxygen, temperature and conductivity, turbidity, Chl and CDOM fluorescence). There is also a thermistor chain and various weather instruments continually monitoring variables such as barometric pressure, wind speed and wind direction.

The Lough Feeagh AWQMS operated well in 2015. The temperature profile indicates a period of stratification between June and October (Fig. 2.6). Summer surface temperatures did not warm to the same degree as in 2012-2014 (Fig. 2-7), and the stratification as less stable (Fig. 2.8), as indicated by the lower Schmidt stability for 2015, in comparison to the previous 10 years.

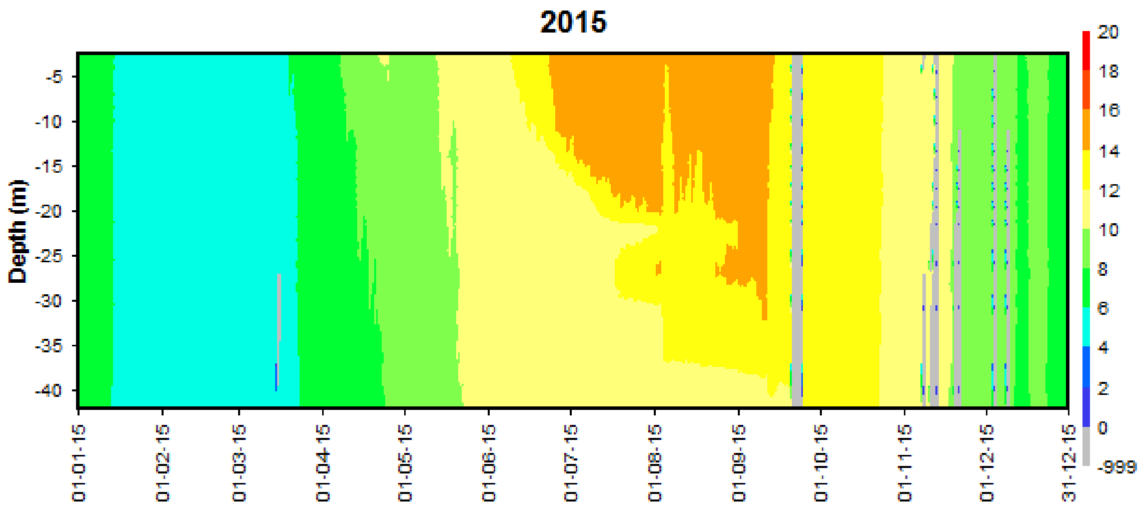


Figure 2-6: Temperature profile for L. Feeagh measured using PRT sensors on the AWQMS for 2015. The grey denotes missing data.

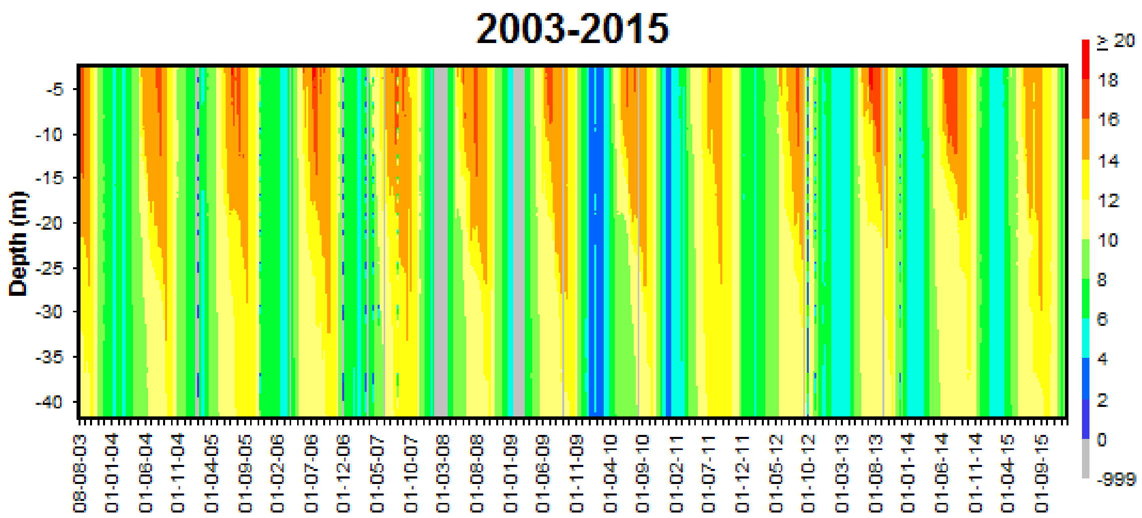


Figure 2-7: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2003-2015. The grey denotes missing data.

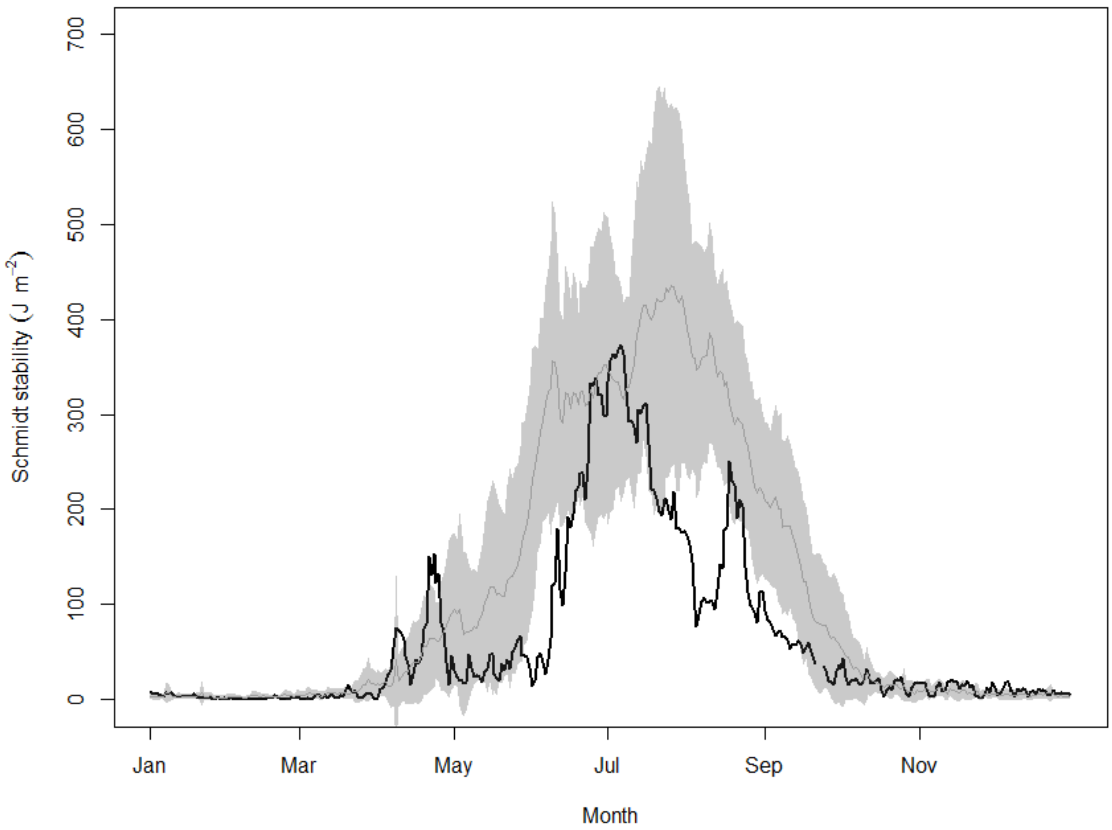


Figure 2-8: Schmidt stability of the water column on Lough Feeagh. The black line indicates the daily measured values for 2015. The grey line indicates the average daily values for the period 2004-2014 ± the standard deviation (shaded grey area).

2.2.5 Lough Furnace

Lough Furnace is situated in the lower end of the Burrishoole catchment. Lough Furnace, (2km from north to south at its widest point, covering an area of 170ha, max depth is 21m with an average depth of 7m) is a cryptodepression tidal lagoon lake. Sea water enters the lake during spring tides but the freshwater exchange ensures relativity low salinities at the surface throughout the year. The lough is thermally stratified throughout the year with spring and autumn inversions and accompanying halo- and oxyclines. Monitoring of L. Furnace commenced in the early 1970s and automatic daily monitoring commenced in May 2008. This AWQMS (Fig. 2.9) has a Datasonde DX5 attached to a profiling winch, enabling temperature, conductivity, dissolved oxygen (% and mg/l), salinity and pH profiles of the lake to be taken. The winch profiles the lake 4 times a day (6am, noon, 6pm and midnight), taking four hours to run a profile and is parked for two hours. There is also a nephelometer and fluorometer positioned one meter below the water column. All parameters are measured every two minutes and an hourly average is then calculated. A weather station is also fully functional on the AWQMS measuring wind direction, wind speed, radiation, relative humidity and barometric pressure.

The winch on the AWQMS was taken out of service at the end of October 2014, to allow for a major upgrade. Unfortunately the winch was not in operation for the majority of 2015, and was only reinstalled in late September. A string of temperature tidbits allow some conclusions about thermal stratification during the year to be made (Fig. 2.10), although it should be noted that the oxycline and halocline can sometimes be at different depths to the thermocline. From the temperature data, it appears that 2015 was a relatively mild year, with warmer winter and cooler summer epilimnetic temperatures.

Figure 2-9: The Automatic Water Quality Monitoring Station (AWQMS) on L. Furnace (left) and the meteorological instruments attached (right)

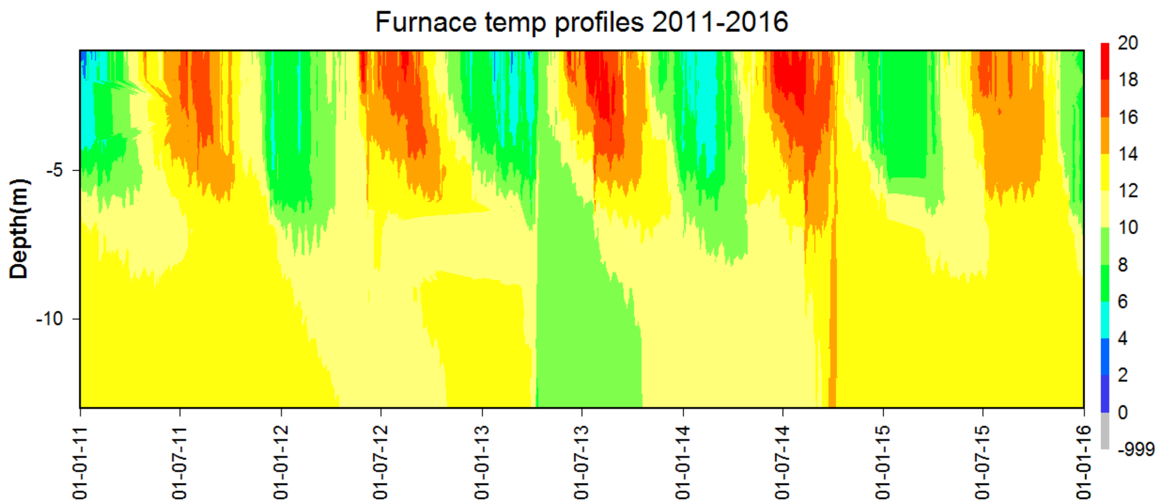


Figure 2-10: Daily average water temperatures (°C) measured every metre at the deepest point in Lough Furnace.

3 Salmonid Rearing

3.1 Salmon Stocks 2014

3.1.1 Ranching

The total release of microtagged smolts of ranched Burrishoole grilse origin was 34,458. Five tag groups (30,087), including one group treated with 'SLICE' for protection against lice infestation during early migration, were released into Lough Furnace on 30th April 2015. One tag group (4,371) was released in the estuary at Burrishoole Abbey on the same day. Mean weights ranged from 62.5 to 79.6 gms.

Tag code details are shown in Table 5.1.

3.2 Salmon Stocks 2015

There was no commercial salmon production in 2015. An estimated 64,600 Burrishoole ranch eyed ova from eight stripping dates were retained for ongrowing. Water temperatures ranged from 8.1^{0}C at the commencement of first feeding in early April to 10.1^{0}C on 8th May when the last group commenced first feeding. Growth and survival were satisfactory with an overall survival of 85% from first feeding to grading in August. Ranch salmon were mixed in October 2015 to produce core medium and large grade release groups. Stock remaining in December 2015 was 37,417.

3.3 Salmon Stocks 2016 (Grilse ova laid down in 2015/'16)

An estimated 57.5% of all returns (54.7% of ranch grilse returns and 92% of 2SW returns) were processed between May and August. Predator damage was estimated to be 3%.

Broodstock collection commenced in early August when, after a period of high rainfall and a large number of returns to the traps in July, numbers dropped significantly. Salmon were held in ponds until transfer to the broodstock holding pond during September 2015 (217 males, 182 females). Broodstock collection continued into December and in total, 793 ranch adults (389 females, 404 males) were held during the stripping period. The number of broodstock held was unusually high as a consequence of the large number of fish recovered during November (n = 214). The majority of these fish were salmon that had chosen to remain in the pool below the Mill Race upstream trap during the summer and autumn.

Average water temperatures decreased from 8.7^{0}C to 7.2^{0}C during December. Salmon were examined weekly, over a seven week period (December 2nd to January 14th 2016), to recover ripe females for egg production. In early December, milt production in the males was poor in some fish but improved over time. Surplus fish were culled on 26th/27th January and at this time approximately 60% of remaining females were ripe.

An estimated 690,000 green ova were produced by 226 females. The average fecundity value was 3,072 ova per grilse female (n=115) and 4,690 ova per 2SW female (n=1). A proportion of each family, from confirmed Burrishoole stock, was retained in the hatchery from each of the six stripping dates, totalling 62,027 eyed ova from 209 females (including 1 2SW) and 246 males. Ova quality and survival was good. Broodstock condition was good throughout the holding period. Thirty ranch salmon broodstock were sampled in January 2016 and subsequently certified by the Marine Institute Fish Health Unit as disease free.

During July and August 2015, 33 salmon (with predator damage) were examined to assess the incidence of Anasakis and post larvae of the cestode *Hepatoxylon trichiuri*. Anasakis was observed in 91% of fish sampled. Where present, levels were recorded as low (< 10 per fish) in 57% and medium (10-50 per fish) in 43% of sampled fish. The presence of cestodes (1 or 2) in the body cavity was noted in 18% of fish sampled. A further 31 broodstock were also examined for parasites in January 2016 and Anasakis was observed in 93.5% of fish sampled. Anasakis levels were recorded as low in 79.3% of fish sampled and the incidence of cestodes was 25.8%, predominately in male fish.

As in the 2014/15 brood season, the relationship between month of capture and readiness to strip in females was examined. Preliminary results indicate that 'early' (August, September) captured females (n=212)) tend to strip later in the season compared to 'late' (October, November) captured females (n=139) as shown in Figure 3-1. Female salmon remaining unripe at the end of the stripping season (n=32) were all 'early' fish. It should be noted that capture date does not equate to return date as many of the fish captured during late autumn were known to have been holding in the Mill Race pool for some months prior to capture. Full results will be reported as an appendix in the 2016 report.

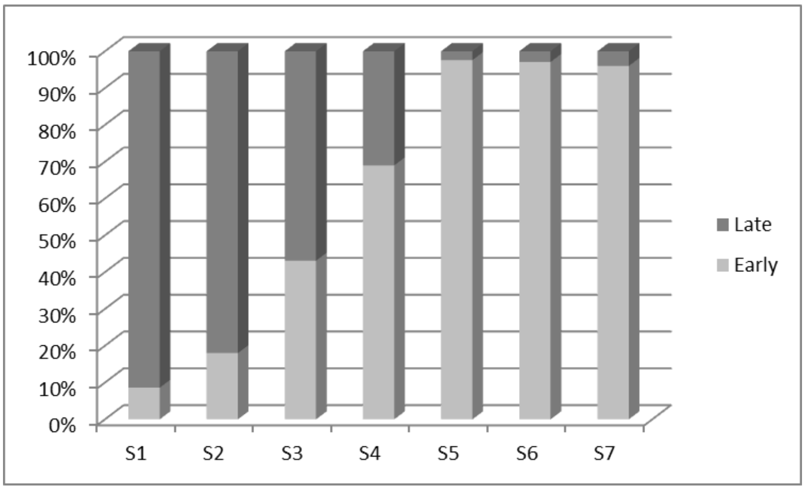


Figure 3-1: Relative proportion of early (August, September) and late (October, November) captured salmon which were ripe on each stripping date. Stripping commenced on 02/12/2015 (S1) and was completed on 26/01/2016 (S7).

3.4 Trout stocks 2016

The Marine Institute are collaborating with UCC on an ERC funded trout project 'Alternative life histories: linking genes to phenotypes to demography'. The overall purpose of the project is to understand how and why individuals develop strikingly different phenotypes and life histories in variable environments and how ecological change affects the composition and dynamics of wild populations. Specifically, the project will investigate the causes and consequences of 'facultative anadromy' in brown trout, the phenomenon whereby some individuals in a population migrate to the sea for part of their lives, while others remain resident in freshwater and never go to sea.

Experimental groups for the laboratory based experiment to be carried out in the UCC aquaculture facility were produced in the hatchery during 2015/16. Trout broodstock collected in the Burrishoole (Shrahevagh and Bunaveela) and Erriff catchments were used to produce experimental groups. Numbers of eyed ova produced were 2,998 Bunaveela (21 females, 21 males), 2,248 Shrahevagh (16 females, 18 males) and 2,652 Erriff (7 females, 10 males). Burrishoole trout broodstock were sampled in January 2016 and subsequently certified by the Marine Institute Fish Health Unit as disease free.

4 Salmon Census Programme

The salmon census and stock assessment programme was continued in 2015 with a full upstream and downstream census of migrating wild salmon. The data provides a valuable index of salmon survivals and stock dynamics for the freshwater components of the stock.

The winter of 2015/16 was characterised by a series of particularly large flood events with one in September, November and 'Storm Desmond' in December. A large flood on the 15/16th November inundated the Mill Race fish fence/Upstream trap.

Storm Desmond caused considerable damage to the Mill Race channel and all the screens on the fish fence were removed from mid-day Saturday 5th Dec 2015 until 8th December. The channel and the right hand third of the fish fence on the Salmon Leap Downstream Trap was also damaged and it was not possible to make a repair to this until March 2016.

It is considered that the November and December floods would not have impacted to any great extent on the upstream counts of Wild Grilse and Wild Salmon counts, as the majority of wild fish would have already migrated and would be expected to be further upstream in the catchment.

4.1 Wild Salmon and Grilse

A total of 635 wild grilse, and 4 previously spawned grilse (from floy tag returns), were recorded moving upstream through the permanent traps during the season (Table 4.1). The water levels were high in early June and the first grilse was recorded on June 5th. However, rainfall amounts were low during the remainder of June and into early July, although salmon continued to migrate upstream in these low water conditions. From the 7th July a period of more persistent rain increased water levels at the traps and good numbers of both wild and ranched salmon were recorded daily. The main run of grilse occurred in July and the maximum daily counts occurred following periods of increased rainfall.

A total of 585 grilse were recorded in the Salmon Leap trap and 50 grilse in the Mill Race trap.

The total number of spring fish recorded in the upstream traps was **11**.

The total wild grilse return to fresh water was **635** and **4** previously spawned grilse.

Table 4-1: Monthly wild grilse totals for the Salmon Leap and Mill Race traps, 2015.

	Mill Race	Salmon Leap	Total	%
May	0	0	0	0.0
June	0	12	12	1.9
July	31	519	550	86.6
August	2	37	39	6.1
September	3	13	16	2.5
October	2	3	5	0.8
November	12	1	13	2.0
December	0	0	0	0.0
	50	585	635	100

Table 4-2: Monthly proportions (%) of the wild grilse run timing 2004-2015.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
May	0.0	0.4	0.5	0.3	0.0	0.0	0.0	0.2	0.1	0.7	0.4	0.0
June	36.0	23.9	1.4	7.7	9.1	4.6	0.9	16.8	29.8	13.2	11.8	1.9
July	41.0	13.2	40.1	56.3	17.9	78.7	75.8	43.4	57.1	45.0	61.6	86.6
August	9.8	39.1	31.9	17.5	62.6	15.5	15.5	29.8	10.1	26.6	19.2	6.1
September	10.9	14.8	22.8	14.9	7.3	0.9	6.7	8.4	2.4	10.3	0.7	2.5
October	1.0	5.5	2.5	1.0	2.9	0.2	1.0	0.6	0.4	2.6	4.8	0.8
November	0.7	3.0	0.5	1.3	0.2	0.2	0.1	0.8	0.0	1.6	1.1	2.0
December	0.5	0.2	0.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0

Table 4-3: Wild salmon, grilse and previously spawned grilse (PSGs identified from floy tag recoveries) totals in the upstream traps, 1970-2015; 5 year means and annual data from 2000..

Year	Total Salmon	Total Grilse	Previously Spawned Grilse
1970-'74	14	1145	
1975-'79	36	703	
1980-'84	35	449	
1985-'89	22	492	
1990-'94	16	421	
1995-'99	12	509	
2000-'04	12	542	
2005-'09	22	642	
2010-'14	27	572	11
2000	6	568	
2001	6	368	
2002	2	648	
2003	18	544	
2004	28	580	
2005	9	532	
2006*	31	530	
2007*	12	1049	
2008	23	548	21
2009	37	549	10
2010	17	686	17
2011	50	523	7
2012	18	671	6
2013	23	710	15
2014	26	271	8
2015	11	635	4

* years where the grilse count was raised to account for loss in the traps.

4.2 Net marked fish in upstream traps

In 2007, the Irish Government introduced a cessation on drift netting in Irish coastal waters. The overall incidence of net marks recorded since the cessation in 2007 remains very low.

The incidence of net marks on wild fish decreased from to 3.7% in 2014 to 2.9% in 2015 and on ranched fish from 6.4% to 0.9% for the same period. The highest monthly occurrence was in July for both wild fish with 3.3% and for ranched fish with 1.5% net marked. Since 2007, the highest incidence of net marks on wild and ranched fish occurred in 2014.

Table 4-4: Percentage occurrence of net marks on wild and reared salmon, 2015.

	Wild Grilse %	n for wild/month	Reared Grilse %	n for reared/month
May	0.0	0	0.0	0
June	0.0	12	0.0	2
July	3.3	549	1.5	839
August	0.0	27	0.0	361
September	0.0	16	0.0	93
October	0.0	5	0.0	10
November	0.0	13	0.0	90
December	0.0	0	0.0	4
Total	2.89%	622	0.93%	1399

4.3 Wild Spawning Stock

The spawning stock (escapement) represents the number of fish available for spawning. It is calculated by subtracting rod caught fish and downstream-displaced fish as well as losses due to poaching, disease and predation, which have been estimated at 5% for wild fish and 10% for reared fish not displaced downstream.

In both 2006 & 2007, an additional number of fish, reared and wild, escaped upstream undetected (see previous reports). It is likely that the wild grilse count for those years were minimum figures and this was taken into account for all calculations based on the 2006 & 2007 spawning escapements.

4.3.1 Spawning escapement and stock

Due to the floods in November and December 2015, it was not possible to accurately determine the spawning stock. While the wild fish count is thought to be virtually complete, some ranched fish were observed crossing the fish fence in the Mill Race, although many of these were recovered in the next few days in the downstream traps.

The total spawning stock in 2015 consisted of at least 583 wild fish and 18 reared fish (Table 4.5). The reared component was derived from 101 reared fish tagged and released upstream plus an additional unknown component (at least 105 fish) that escaped upstream during the November/December floods. Given the low reared fish kelt count (9), it is thought that the number of reared fish remaining in the catchment to spawn was low.

Table 4.6 gives the annual total spawning escapement, the wild escapement and the reared fish component. The spawning escapement of wild fish in 2007 was the highest observed over the last two decades. Particularly poor wild escapement was recorded in the 1990s, in 2001 and in 2014.

Table 4-5: Spawning stock of salmon and grilse, 2015.

	Wild grilse (1SW) & previously spawned grilse	Wild Salmon (2SW)	Ranched fish released upstream
Counted in trap	639	11	101
Rod Feeagh	0	0	0
Culled	0	0	0
Broodstock	0	0	206
Estimated morts.	30	1	-
Displacement	36	0	206
Spawning stock	**573**	**10**	**18***

* 9 fish counted as kelts, to account for the gap in SLDT fence Dec-Mar, we have conservatively doubled it.

Table 4-6: Spawning escapement, 1970-2015.

	Maximum spawning escapement	Wild fish component	Reared fish component
1970-'74	1126	986	140
1975-'79	725	683	42
1980-'84	474	430	44
1985-'89	662	428	232
1990-'94	603	348	254
1995-'99	519	428	95
2000-'04	516	494	21
2005-'09	624	587	38
2010-'14	571	544	27
2005	503	472	31
2006	552	520	32
2007	1038	958	80
2008	512	495	17
2009	517	489	28
2010	652	617	38
2011	548	512	36
2012	668	640	28
2013	702	691	11
2014	284	260	24
2015	601	583	18*

* estimated, see table 4.5.

4.3.2 Wild salmon broodstock stripped December 2015

No wild fish were stripped in 2015.

4.4 Survival from Ova to Grilse

The relevant brood year for the 2015 grilse was 2011 with ova hatched in 2012 and smolt migration in 2014 (Table 4.7).

As in previous years, it has been assumed for the purpose of estimating survival that ranched grilse spawned naturally. Specific data are not currently available on differential survival rates of wild and ranched stocks spawned in the wild. All relevant calculations are based on parameters set out in the Ann. Rep. No. 19, 1974.

Table 4-7: Survivals from ova to smolt and smolt to grilse.

Spawning escapement in 2011	548
No. of females	274 - 301
Ova deposition	1,096,000 – 1,240,261
No. of smolts in traps 2014	8150
No. of smolts released	7957
Survival ova to smolt*	0.74 – 0.66
No. returning grilse 2015	635
Survival smolt to grilse	8.0%
Survival to grilse per grilse female	***2.3 –2.1***

* two estimates of the % females in the run using 50% and 55%

4.5 Ova to Smolt Survival

The survival of ova to smolt recorded in 2015 was 0.74 from a spawning escapement of 548 adults. For the five years prior to 2007 the average spawning stock was 539 and the average survival of ova to smolt was 0.7.

There was a considerable decrease in the percentage return of grilse from 9.4% (2013) to 4.5% in 2014, from a wild smolt output in 2013 of 5960. In 2015, the wild grilse return rate was 8.0% from a smolt output of 7957 in 2014. The survival to grilse per grilse female was 2.3 – 2.1 (Table 4.8).

Table 4-8: Percent survivals for ova to smolt and grilse per female grilse spawner; comparative data for 5-year averages from 1970-1989 and values for the individual brood years from 1990 onwards.

Brood year-class	% survival rates ova to smolt	survival rates to grilse per grilse female spawner
1970-'74	0.48 - 0.62	1.4 - 1.7
1975-'79	0.63 - 0.73	1.5 - 1.7
1980-'84	0.61 - 0.69	1.7 - 1.9
1985-'89	0.44 - 0.45	1.4 - 1.5
1990	0.47 - 0.54	1.8 - 2.0
1991	0.47 - 0.53	1.8 - 2.0
1992	0.48 - 0.54	1.3 - 1.5
1993	0.39 - 0.45	1.5 - 1.6
1994	0.36 - 0.41	1.3 - 1.4
1995	0.83 - 0.93	1.9 - 2.1
1996	0.53 - 0.61	1.8 - 1.9
1997	0.52 - 0.59	1.4 - 1.5
1998	0.58 - 0.60	2.4 - 2.6
1999	0.79 - 0.70	1.8 - 2.0
2000	0.56 - 0.64	1.9 - 2.1
2001	1.30 - 1.10	2.9 - 2.6
2002	0.56 - 0.64	1.7 - 1.9
2003	0.68 - 0.76	3.7 - 4.1
2004	0.53 - 0.60	1.8 - 2.0
2005	0.69 - 0.61	2.0 - 2.2
2006	0.75 - 0.67	2.4 - 2.6
2007	0.34 - 0.30	0.9 - 1.0
2008	0.65 - 0.57	2.4 - 2.6
2009	0.75 - 0.66	2.7 - 2.5
2010	0.49 - 0.43	0.8 - 0.9
2011	0.66 - 0.74	2.3 - 2.1

4.6 Wild Salmon Smolts

A total of 7034 smolts were recorded in the downstream traps in 2015 (Table 4.9). Water levels were generally low for much of April and warm sunny conditions during the middle of the month resulted in very low water conditions particularly at the Salmon Leap (Fig. 1). The first peak of migration occurred on 30th April when 410 smolts were recorded following a period of rainfall. Intermittent periods of rainfall during the first week of May maintained suitable flow rates at the traps for migration and the main peak of migration occurred on May 7th when 2267 smolts were recorded. The total of 7034 smolts recorded in 2015 was lower than the total of 8150 in 2014 (Table 4.10).

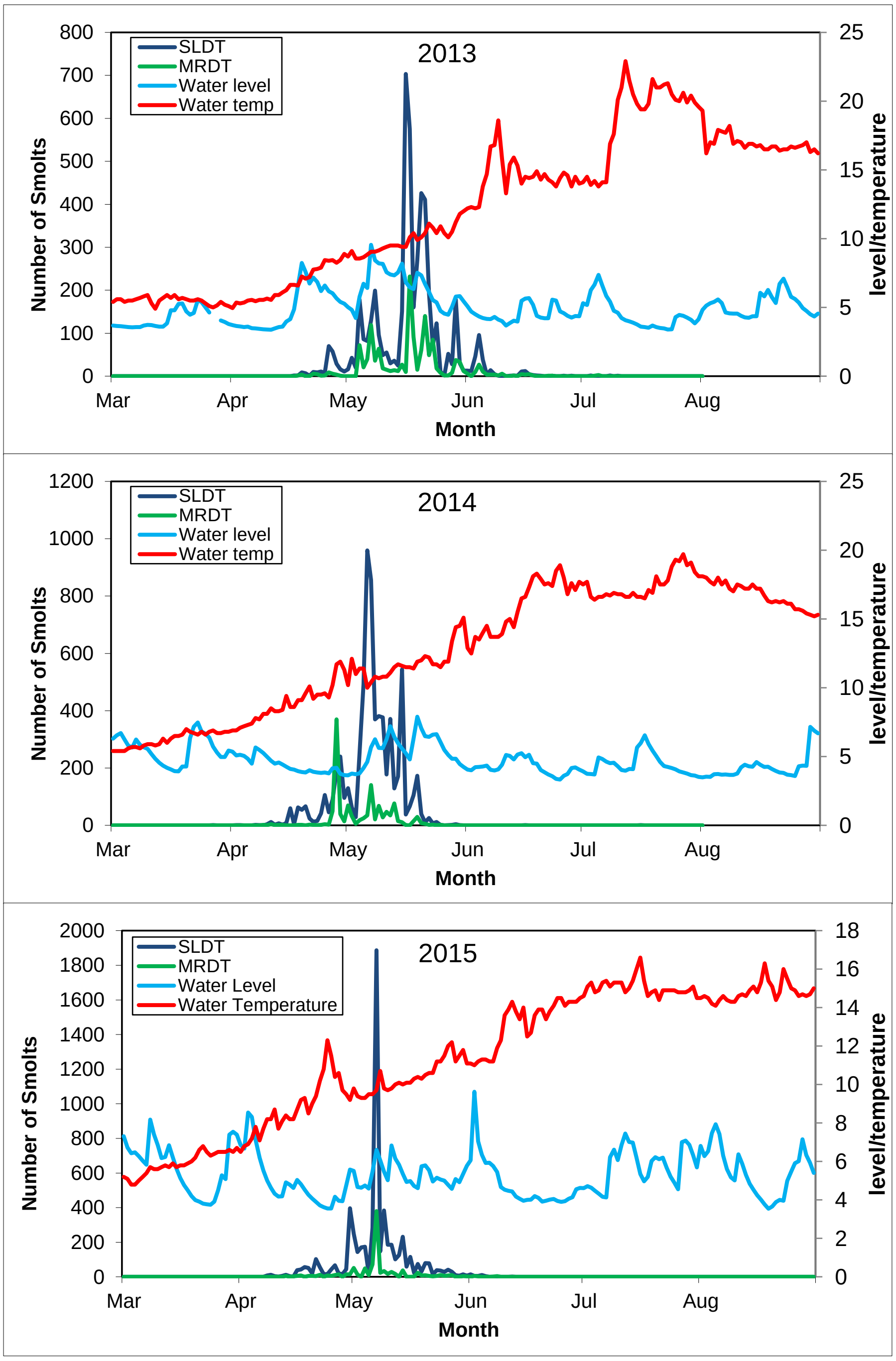


Figure 4-1: Timing of the 2013, 2014 and 2015 wild salmon smolt runs in the Salmon Leap and Mill Race traps with daily midnight water level (m x 10) and midnight temperature (⁰C).

Table 4-9 : Number of wild salmon smolts counted in 2015.

Month	Salmon Leap Down Trap	Mill Race Down Trap	Total
March	3	1	4
April	1035	122	1157
May	4974	835	5809
June	43	18	61
July	2	1	3
August	0	0	0
September	0	0	0
TOTAL	6057	977	7034

Table 4-10: Annual numbers of wild salmon smolts recorded in the downstream traps.

Year	1990-'94	1995-'99	2000-'04	2005-'09	2010-'14	2010	2011	2012	2013	2014	2015
Smolts Counted	5618	7052	7490	7351	7195	7123	6629	7717	6357	8150	7034
Smolts Released		6967	7340	7138	6966	6979	6390	7542	5960	7957	6832

4.7 Wild Salmon Kelts

4.7.1 Census

Kelts migrate downstream after spawning. A total of 159 wild salmon kelts were recorded in the downstream traps between December 2014 and June 2015. The main downstream migration was recorded during March when 44.0% of the total migration was recorded (Table 4.11).

The overall survival of kelts from the spawning stock in 2014 was 61.2%.

Table 4-11: Numbers of wild salmon kelts counted in 2015.

Month	SLDT	MRDT	Total
December '14	11	1	12
January '15	23	11	34
February	25	1	26
March	63	7	70
April	10	6	16
May	1	0	1
June	0	0	0
	133	26	159

4.7.2 Tagging of wild kelts

Following the cessation of drift netting during 2007 and the corresponding increase in the wild spawning stock at Burrishoole, annual tagging of the wild kelts recommenced during 2008.

A total of 150 floy tagged kelts were released from the downstream traps in 2015. During the summer of 2015 a total of 4 previously spawned grilse were recovered. The percentage recovery of PSGs for 2015 was 2.7% (Table 4.12).

Table 4-12: Comparison of annual salmon kelt runs.

Year	Kelt Quality Grade				
	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980-84	82	18	6.7	48.7	9.7
1985-89	88	21	5.1	43.2	8.4
1990-94	92	31	4.8	61.4	6.6
1995	74	28	18.3	59.9	2.3
1996	88.1	27	10.1	53.1	4.0
1997	93.7	33.5	6.3	58.9	*
1998	94.3	30.8	5.7	67.6	*
1999	90.6	38.5	4.5	76	*
2000	92.5	44.5	5.5	62.1	*
2001	97	38.5	2.8	72.5	*
2002	91.3	40.9	7.8	49.6	*
2003	95.5	37	3.5	42.3	*
2004	89.9	36.3	9	53.2	*
2005	83.3	35.5	15.3	57.6	*
2006	82.2	36.1	16	54.4	*
2007	95	37.3	4.1	**	*
2008	93.2	26.9	6.8	**	5.6
2009	96.1	20.8	3.3	43.8	4.9
2010	98.1	13.5	1.3	34.2	10.1
2011	95.9	22.7	0.5	35.5	4.1
2012	96.7	20.8	2.8	54.7	3.6
2013	95.1	29.6	4.6	53.9	4.5
2014	91.3	40.7	6.7	51.4	2.4
2015	88.6	27.8	9.8	61.2	2.7

* no kelt tagging

** see section 4.7 (2007 report)
A = % healthy kelts in kelt run
B = % males in kelt run
C = % lightly marked
D = % survival from wild spawning escapement
E = % recapture of previously spawned grilse in first year

5 Reared Salmon Census Programme

A programme of rearing and releasing tagged salmon has been carried out in Burrishoole since the early 1960s. The stock was based originally on donor wild salmon from the Burrishoole system and the stock has been closed since using returning tagged fish as broodstock. Additional experimental groups are sometimes released and these are freeze branded and differentially tagged so as to distinguish them from the core ranched stock and avoid including them in the ranched broodstock. The ranched stock facilitates data collection and comparison with the wild stock without putting undue stress or mortality on the wild stock – in this report the ranched stock are known as reared grilse and reared 2SW salmon.

As described in Chapter 4, the winter of 2015/16 was characterised by a series of particularly large flood events with one in September, November and 'Storm Desmond' in December. A large flood on the 15/16th November inundated the Mill Race fish fence/Upstream trap.

Storm Desmond, in December, caused considerable damage to the Mill Race channel and all the screens on the fish fence were removed from mid-day Saturday 5th Dec 2015 until 8th December. The channel and the right hand third of the fish fence on the Salmon Leap Downstream Trap was also damaged and it was not possible to make a repair to this until March 2016.

As discussed in Section 4.3.1, the reared component of the spawning escapement was derived from 101 reared fish tagged and released upstream plus an additional unknown component (at least 105 fish) that escaped upstream during the November/December floods. It is thought that the fish that moved upstream uncounted returned downstream soon after and were recovered from the downstream traps. Given the low reared fish kelt count (9), it is thought that the number of reared fish remaining in the catchment to spawn, after downstream displacement was taken into account, was low. Further analysis of the floy tags may be informative.

5.1 Coastal Returns

Details of coastal returns of Burrishoole fish are available in the Marine Institute 'National Report for Ireland - The 2015 Salmon Season' report.

5.2 Return rate of reared and wild grilse

A total of 1912 microtags were recovered from reared fish returning to Burrishoole in 2015 consisting of 16 different microtag codes. Of these 138 were identified as multi sea winter fish and 1774 as one sea winter (grilse). 1505 of the grilse were from a core smolt release of 34703 smolts in 2014 resulting in an overall return rate to Burrishoole of 4.3%, somewhat higher than the 3.23% in 2014 and the 2.9% in 2013.

The percentage return of wild grilse in 2015 was 8.0%, higher than 2014 but still lower than the previous two years. In 2014, the return rate was 4.5%, the 2013 return rate was 9.4% and in 2012 it was 10.5%.

5.3 Recapture of Reared 2SW Fish

The total number of microtagged 2SW reared fish recorded in Burrishoole during 2015 was 138 comprising of 7 core release groups.

5.4 Smolt Releases 2015

A total of 34,458 ranched smolts were released from Burrishoole during 2015. They consisted of six individual microtag codes, five of which were released into Lough Furnace and one into the estuary at Burrishoole Abbey. All six microtag group releases were carried out on April 30th. For additional information, see section 3.1.1.

Table 5-1: Details of microtag codes and smolt release groups 2015.

Group ID	Tag Code	Mean Wt	Mean Length	No. Released	Date released
Core	47/6/99	78.24	18.7	6,425	30/04/2015
Core	47/7/11	71.90	18.4	6,442	30/04/2015
Core	47/7/23	78.30	18.9	6,320	30/04/2015
Core	47/7/24	75.60	18.6	6,446	30/04/2015
Core (Abbey)	47/7/36	62.51	17.6	4,371	30/04/2015
Core	47/7/39	63.68	17.7	4,454	30/04/2015

5.5 Reared kelts

In 2013, a total of 105 ranched fish were floy tagged, swabbed and released upstream. Between June and December, 93 (88.6%) of the fish released up were recaptured in the downstream traps, the majority of which were retained as broodstock in the Smolt Unit. In 2014 a further 10 ranched fish were recorded in the downstream traps. Therefore, a total of 103 (98%) of the 105 fish released upstream in 2013 were accounted for in the downstream traps.

In 2014, a total of 117 ranched fish were released upstream during the summer. By the end of December 2014 a total of 97 fish (83%) were recaptured in the downstream traps of which 86 were transferred to the broodstock ponds. In 2015, an additional 15 ranched grilse were recorded in the downstream traps. Therefore, a total of 111 (95%) of the 117 fish released upstream in 2014 were accounted for in the downstream traps.

In 2015, a total of 101 ranched fish were released upstream during the summer and a further component escaped upstream during the floods in November and December. An unknown component of those fish may also have been displaced downstream during the same floods. Therefore, it is not possible to calculate the efficiency of retrieval of the 2015 ranched component. However, the number of ranched grilse kelts counted in 2016 was low (9) indicating that the number that potentially stayed in fresh water to spawn was low. In Sec. 4.3, the 9 was raised to 18 to take account of the damage to the SLDT fish fence in Jan-Mar 2016. In comparison, retrieval of wild kelts was relatively good during the same time period supporting the view that the number of ranched kelts remaining in fresh water was low.

6 Wild Sea Trout Census Programme

6.1 Upstream Movements: Timing and Numbers.

A total of 59 wild silvered sea trout and a further 79 non-silvered trout migrated upstream through the traps in 2015. Of the silvered trout, 16 were adults and 43 (72.9%) were finnock. The numbers are compared with other years in Table 6.1. Of the total run of migratory (silvered and unsilvered) trout (138), 57.3% were unsilvered. For the purposes of this report, the unsilvered trout are not included with the sea trout. Table 6.1 shows that the numbers of sea trout have not recovered in the Burrishoole system and have shown a ten-fold drop since the 1970s.

Table 6-1: Annual runs of sea trout recorded in the traps.

Year	Mill Race	Salmon Leap	Total	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	72	206	
1995-99	86	91	177	
2000-04	32	64	97	
2005-09	21	44	65	
2000	33	78	111	
2001	31	58	89	
2002	26	89	115	
2003	45	33	78	
2004	26	64	90	
2005	5	10	15	
2006	16	22	38	
2007	35	59	94	
2008	4	36	40	
2009	45	93	138	
2010	10	62	72	
2011	15	53	68	
2012	19	120	139	
2013	20	50	70	
2014	16	126	142	
2015	31	28	59	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

The timing of the sea trout run in 2015, and in previous years, expressed in monthly percentages, is given in Table 6.2. The highest proportion of sea trout, both finnock and adults, moved upstream in July (75%) and August (19%). The unsilvered trout moved upstream in July and August and again in October and November.

Table 6-2: Timing of the Burrishoole (a) silvered sea trout run and (b) unsilvered trout run (in monthly percentages). (n = no. of trout).

(a) Silvered Trout

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04 (483)	2005-'09 (325)	2010 (72)	2011 (68)	2012 (139)	2013 (70)	2014 (142)	2015 (59)
May	-	0.2	0.5	0.1	3.1	2.0	1.3	0.0	13.2	1.4	1.4	0.0	0.0
June	13.1	24.6	9.4	8.4	8.6	16.7	9.0	0.0	0.0	11.5	4.3	14.8	6.3
July	54.4	44.9	62.2	55.0	42.4	37.5	32.5	85.9	16.2	60.4	30.0	77.5	75.0
Aug	15.8	10.3	18.4	16.5	19.3	26.4	38.1	8.5	35.3	18	44.3	5.6	18.8
Sept	7.6	14.8	3.7	8.5	9.8	5.7	13.6	5.6	22.1	5	5.7	0.7	0.0
Oct	6.4	3.5	4.1	7.9	12.2	10.2	4.7	0.0	7.4	2.9	12.9	1.4	0.0
Nov	2.4	1.5	1.5	2.9	4.3	1.5	0.7	0.0	5.9	0.7	1.4	0.0	0.0
Dec	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0

(b) Unsilvered Trout

	2005 (86)	2006 (61)	2007 (94)	2008 (76)	2009 (91)	2010 (104)	2011 (87)	2012 (47)	2013 (101)	2014 (91)	2015 (79)
April	0	0	2.2	2.6	2.2	0.0	3.4	0	1.0	3.3	1.3
May	4.7	16.4	5.4	3.9	5.6	1.0	5.7	0	3.9	9.9	3.8
June	10.5	9.8	19.4	13.2	8.9	0.0	3.4	21.7	6.9	12.1	2.5
July	4.7	16.4	25.8	21.1	23.3	44.2	12.6	17.4	9.9	30.8	34.2
August	43	11.5	4.3	31.6	12.2	16.3	14.9	13.0	34.7	4.4	20.3
Sept	12.8	13.1	6.5	7.9	7.8	17.3	11.5	13.0	9.9	3.3	7.6
Oct	9.3	27.9	7.5	9.2	24.4	7.7	11.5	19.6	24.8	25.3	12.7
Nov	10.5	3.3	20.4	2.6	14.4	11.5	36.8	6.5	5.0	6.6	13.9
Dec	4.7	1.6	8.6	7.9	1.1	1.9	0.0	8.7	5.0	4.4	3.8

6.2 Spawning Escapement

With the continuation of the catch and release bye-law into the 2015 fishing season, no sea trout were reported killed by anglers on L. Feeagh in 2015. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 138, of which 79 were non-silvered sea trout.

Table 6-3: Annual spawning escapement of sea trout into freshwater, 1970-2015.

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04	2005-'09	2011	2012	2013	2014	2015
Max. Escap.	2090	1146	906	231	289	156	146	155	186	171	233	138
Revised	1622											

6.3 Downstream Movements, Sea Trout Smolts

The 2015 smolt run amounted to 426 smolts, most of which were released downstream (Table 6.4). Few smolts were recorded from January to March. The main migration occurred in May (68%) and was strongly regulated by both water level and water temperature (Fig. 6.1). The 2015 smolt count was similar to that in 2014 and low compared to the previous few years (Table 6.5).

Table 6-4: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

Month	Salmon Leap	Mill Race	Total	%
January	0	0	0	0.0
February	0	0	0	0.0
March	2	0	2	0.5
April	97	7	104	24.4
May	271	18	289	67.8
June	22	5	27	6.3
July	3	1	4	0.9
Total	395	31	426	
Number Released Downstream			423	

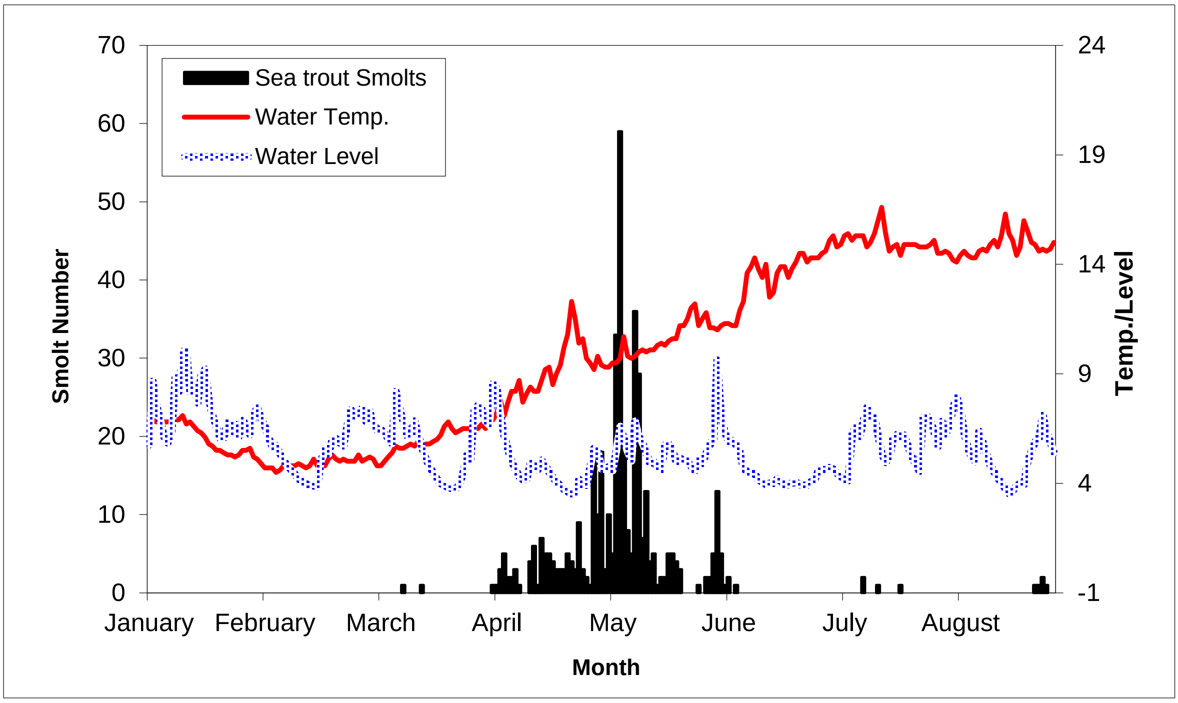


Figure 6-1: Timing of the 2015 wild sea trout smolt migration with daily midnight water level (m x 10) and midnight temperature (^{0}C).

Table 6-5: Annual sea trout smolt numbers in Burrishoole for 1970 to 2015.

	1970-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2011	2012	2013	2014	2015
Number of Smolt	4176	4038	4119	1531	1361	816	609	620	632	485	427	426

A total of 408 wild trout smolts were measured in 2015. Length measurements were taken to facilitate an estimated age breakdown of the smolt run. The estimated statistics for the 2015 smolts were a mean length of 19.3 cm and a range from 13.5 to 26.5 cm and the length frequency is presented in Figure 6.2 compared with that of 2013 and 2014. This gave an estimated age of 90.9% 2 year old and 9.1% 3 year olds.

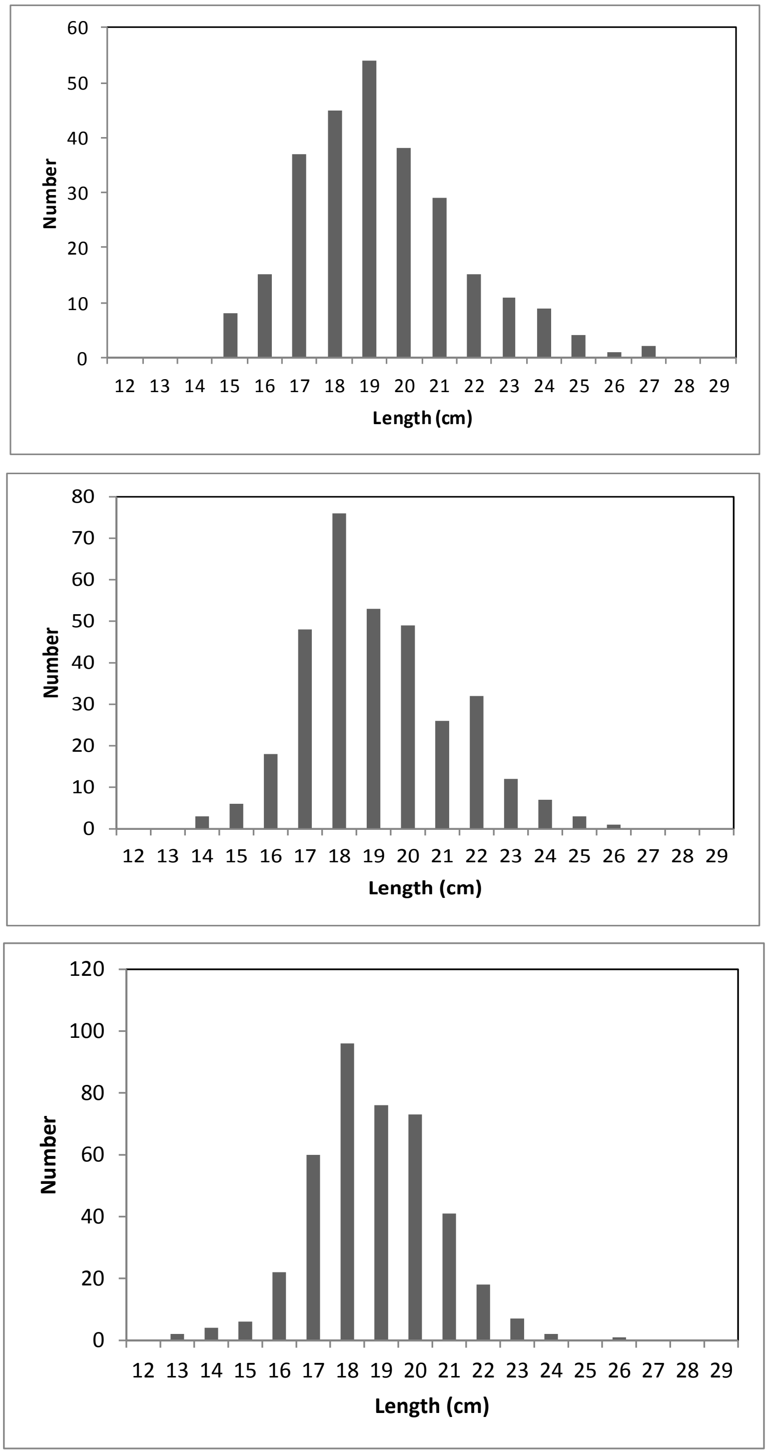


Figure 6-2: Length distributions for smolts in the Burrishoole system, top graph 2013 (n=268), middle graph 2014 (n=333) and bottom graph 2015 (n=408).

6.4 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock being displaced downstream. It is known through mark-recapture studies that a proportion of the 1+ autumn trout do return the following year as silvered finnock. These runs of trout would appear to becoming more prolonged with substantial numbers of un-silvered 0+ and 1+ trout continuing to migrate downstream in the early months of the year.

A total of 459 juvenile trout entered the downstream traps between July 2015 and May 2016 (Table 6.6). The percentage of 0+ trout that migrated over the period was 27.2% (Table 6.7).

Table 6-6: Numbers of migrating autumn juvenile trout in 2015, to the end of May 2016.

	0+		1+		Total	
Month	Salmon Leap	Mill Race	Salmon Leap	Mill Race	Salmon Leap	Mill Race
July	1	0	10	0	11	0
August	22	1	5	2	27	3
September	21	0	29	6	50	6
October	16	1	35	1	51	2
November	37	6	122	9	159	15
December	3	1	67	13	70	14
January '16	5	0	9	2	14	2
February '16	3	0	4	1	7	1
March '16	3	0	6	2	9	2
April '16	2	1	4	1	6	2
May '16	2	0	5	1	7	1
Total	115	10	296	38	411	48
Overall Total	125		334		459	

Table 6-7: Percentage of 0+ juvenile trout (<10cm) in the trapped autumn migrating trout.

Year	% 0+	Year	% 0+
1982	50.0	1999	42.0
1983	N/A	2000	47.8
1984	55.8	2001	56.3
1985	30.3	2002	32.8
1986	16.1	2003	48.9
1987	35.3	2004	35.5
1988	60.9	2005	37.3
1989	37.2	2006	51.2
1990	35.2	2007	27.9
1991	26.0	2008	28.2
1992	38.2	2009	25.0
1993	27.6	2010	34.9
1994	16.8	2011	37.6
1995	25.3	2012	47.3
1996	34.0	2013	36.1
1997	18.7	2014	36.6
1998	33.5	2015	27.2

6.5 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ year olds, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known. It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus the figures for total recruitment up to this time are over-estimated (Table 6.8).

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 6.9). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts. The fate of 1+ unsilvered juveniles migrating down in January to May is unknown but seems unlikely these will contribute to the 2+ spring smolt migration.

Table 6-8: Estimates of total migrant trout recruitment up to 1981.

Year	Smolt Total	Autumn trout (preceding year)	Total Recruitment
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

Table 6-9: Estimates of total migrant trout recruitment from 1982 to date.

Year	Smolt Total	1+ Autumn trout (preceding year)	Total Recruitment
1982-84	3714	1203	4917
1985-89	3706	1063	4778
1990-94	1788	399	2187
1995-99	1361	498	1860
2000-04	816	578	1377
2005	777	590	1367
2006	628	251	879
2007	593	377	970
2008	393	534	927
2009	657	495	1152
2010	213	267	480
2011	620	501	1121
2012	632	493	1125
2013	485	536	1021
2014	427	351	778
2015	426	481	907

6.6 Marine Survival

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock (0+ sea age) in the same year historically ranged from 11.4% to 32.4% (Fig. 6.3). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's rising to 16.7% in 1999, 18.1% in 2009 and 17.5% in 2010 – the highest return rates since 1986. These increases were not, however, always sustained in subsequent years and there was a collapse in 2005 down to 1.5%. This was associated with the heaviest infestations of sea lice observed in the Burrishoole area since 1992. The return of smolt as finnock in 2011 was 5.8%, 13.8% in 2012, 11.0% in 2013 and 29.5% in 2014 – the highest recorded level since the mid-1970s. This fell again in 2015 to 10.2%.

The total survival of smolts to their first return to freshwater as finnock in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills *et al*, 1990)) also showed a drop in survival from 1987 to 1989 (Fig. 6.4).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.2% for the 1993 year class of smolts. There was a further increase in 1994 to 17.0% but a drop in 1995 to 8.4%. There were marginal improvements again in 1996 (12.8%) and 1997 (13.1%), a drop to 8.3% in the 1998 year class and a marked improvement in the 1999 year class where marine survival was 20%, the highest recorded in 12 years and back within the pre-collapse historical range. Total survival increased for the 2009 cohort to the highest recorded level since 1988 of 23% and to 23.2% for the 2010 cohort. For the 2011 cohort of smolts, it was 10.2% and for the 2012 cohort it was 17.1%. In 2013 it was 14.4% and rose to 33.0% in 2014.

NOTE: The data used in Chapter 6.6 have been updated in 2014 following a comprehensive data quality control project. None of the changes were significant and the main changes were in 2011 and 2012 following a reclassification of trout considered to be silvered and unsilvered.

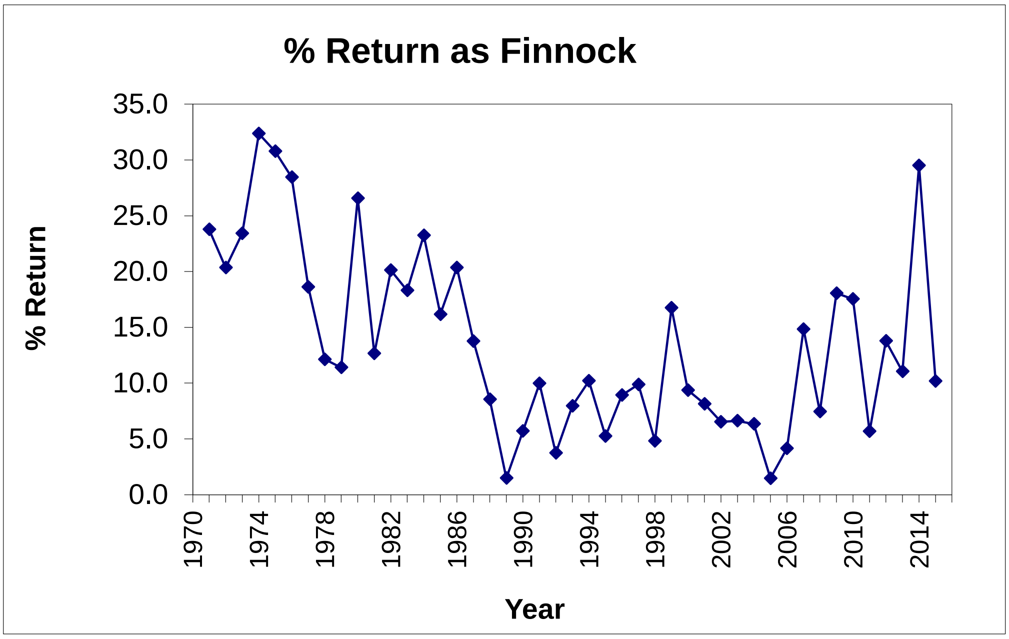


Figure 6-3: Annual percentage return of smolts returning as finnock to the Burrishoole system.

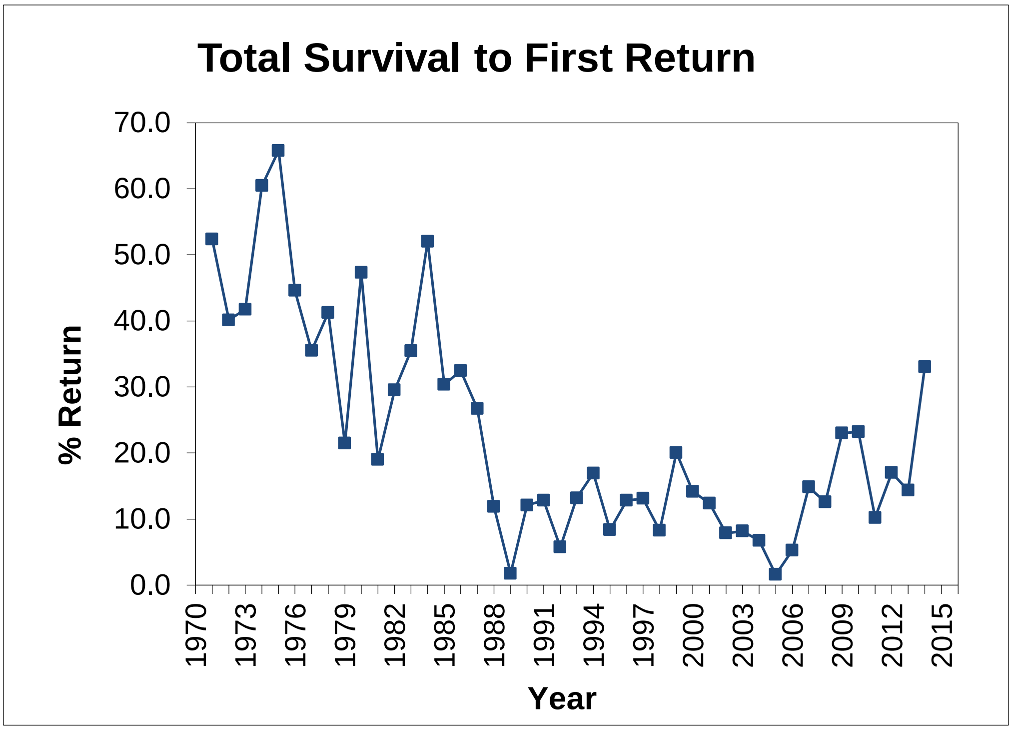


Figure 6-4: Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

6.7 Sea Trout Kelts

Table 6.10 gives the numbers of sea trout and brown trout kelts, both spawned and immature, counted downstream in the winter of 2014 and spring of 2015.

The freshwater survival of kelts is given in Table 6.11. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 6.11. In addition to the size overlap, trout counted upstream as unsilvered migrants may be counted downstream as silvered kelts, and immature autumn downstream migrants may be misidentified as brown trout kelts, both causing additional difficulties in making survival estimates.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may over-winter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

In 2014/15, overall sea trout kelt survival was 87.1% and for finnock only (small sea trout) it was 88%.

Table 6-10: Timing and numbers of sea trout kelts for the 2014/2015 season.

Month	Large ST	Small ST	BT	Total ST	Total Trout
October '14	0	5	9	5	14
November	1	8	14	9	23
December	3	38	53	41	94
January '15	1	12	10	13	23
February	1	0	3	1	4
March	9	15	1	24	25
April	13	31	3	44	47
May	0	15	1	15	16
June	0	1	0	1	1
Total	28	125	94	153	247

Table 6-11: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)	Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66	1996	127.70%	" *
1977	63	45	1997	97.00%	" *
1978	50	66	1998	140.10%	" *
1979	33	107*	1999	110.40%	" *
1980	50	82	2000	70.10%	"
1981	44	345*	2001	82.00%	" *
1982	53	203*	2002	129.60%	" *
1983	63	177*	2003	66.10%	"
1984	74	210*	2004	120.50%	"*
1985	70	98	2005	142.20%	"*
1986	66	72	2006	110.50%	"
1987	58.70%	(combined)	2007	228.90%	"**
1988	65.50%	"	2008	98.90%	"**
1989	68.70%	"	2009	107.50%	"*
1990	79.00%	" *	2010	59.40%	"
1991	98.70%	" *	2011	88.90%	"*
1992	89.50%	" *	2012	117.65%	"*
1993	96.70%	" *	2013	161.33%	"*
1994	104.60%	" *	2014	87.14%	"
1995	96.20%	“ *	2015	92.81%	“

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

7 Silver Eel Census Programme

7.1 Numbers

Silver eel trapping was continued in 2015. In 2015, the timing of the run was different to the general pattern, with 31% migrating in October and 32% migrating in November (Table 7.1). Figure 7.1 shows the daily counts of silver eels. Note Table 7.1 has been reconfigured with the silver eel year going from May to April.

The total run amounted to 1073 eels. As in other years, the highest proportion of the total catch (80%) was made in the Salmon Leap trap.

There was considerable influence on the run timing due to low water levels in late September and early October but then a series of large floods occurred in late October, November and December. Some eels were noted lost from the Mill Race trap in the September flood and the data have been amended to account for that. However, the large floods in December completely inundated the whole Mill Race area and damaged a section of the Salmon Leap channel. No eels were observed damaged or caught against screening and it is thought that the losses were minimal. Once the traps were operational again the following week, in spite of continual high water through into February and March, almost no eels were counted.

Table 7-1: Timing and numbers of the 2015/'16 silver eel run.

	Salmon Leap	Mill Race	Total	%
May	0	0	0	0.0
June	0	1	1	0.1
July	42	18	60	5.6
August	63	44	107	10.0
September	190	42	231	21.6
October	275	55	330	30.7
November	288	55	343	31.9
December	0	0	0	0.0
Jan. 2016	0	0	0	0.0
February	0	0	0	0.0
March	0	0	0	0.0
April	1	0	0	0.1
Total	859	215	1074	

7.2 Size

Sampling of individual eels (n = 366) gave an average length of 43.8cm (range: 21.4 – 97.4cm) and an average weight of 192.4g (Table 7.2). The length frequency distribution is presented in Figure 7.2 along with those for 2013 and 2014 for comparison.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4,400, fell to 2,200 between 1983 and 1989 and increased again to above 3,000 in the '90s (Fig. 7.3). There was an above average count in 1995, possibly contributed to by the exceptionally warm summer. The count in 2001 of 3875 eel was the second highest recorded since 1982. The average weight of the eels in the samples has been steadily increasing from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Fig. 7.3). The annual count and average weight in 2010 and 2011 were both below the mean for the last decade.

In 2012, the majority of the eel run was sampled (n=3317; 99.5%). The run increased from 1969 in 2011 to 3335 in 2012 and the average weight decreased from 180 to 163.5g. The sex ratio changed from 24% to 45% over the past five years. Male eels have remained the same length over the past 15 years (36cm) whereas the females have changed from 53cm (1997-2005) to 50cm (2008-2012) and they were 49.2cm in 2012.

In 2015, the migration was 1072 eels and 366 were sampled. The mean weight was 192.4g and the proportion of male eels was 44.7%.

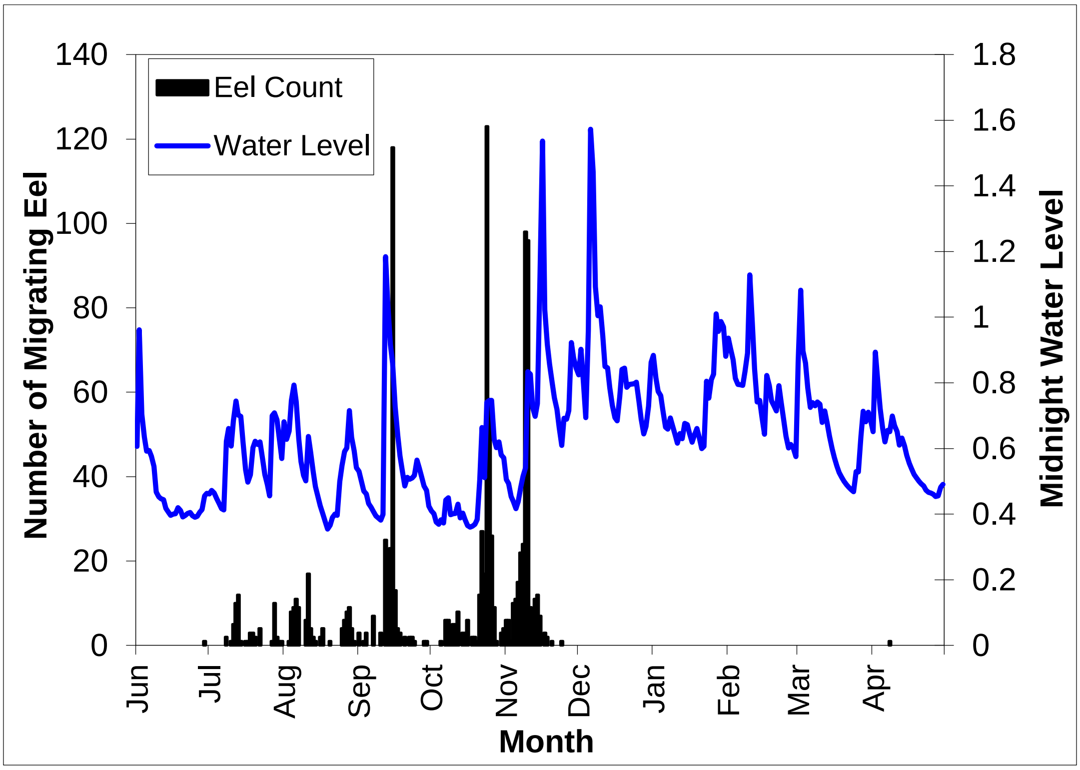


Figure 7-1: Daily counts of downstream migrating silver eel and mid-night water levels (m).

Table 7-2: Comparative data for the silver eel runs since 1971.

Years	Number Sampled	Mean. Weight (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1991 - '95	3441	227
1996 - '00	3958	212
2001	850	238
2002	732	207
2003	650	177
2004	382	216
2005	587	237
2006	493	225
2007	571	201
2008	796	234
2009	220	209
2010	982	192
2011	1835	180
2012	3315	163
2013	1301	157
2014	650	196
2015	366	192

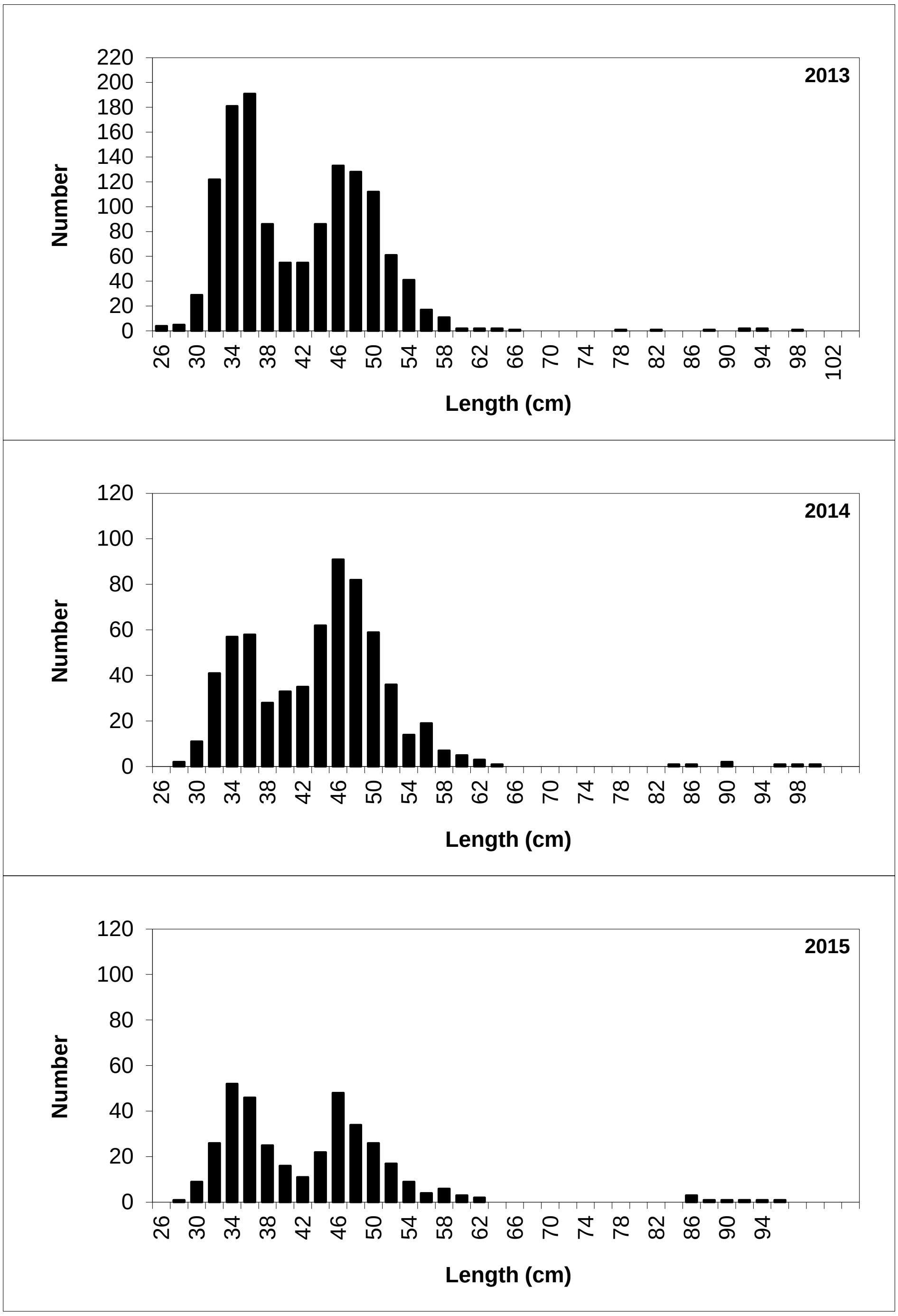


Figure 7-2: Length frequency of sub-samples of silver eels trapped in the downstream traps, 2013 (n=1329), 2014 (n=650) and 2015 (n=365). Note change of y-axis scales.

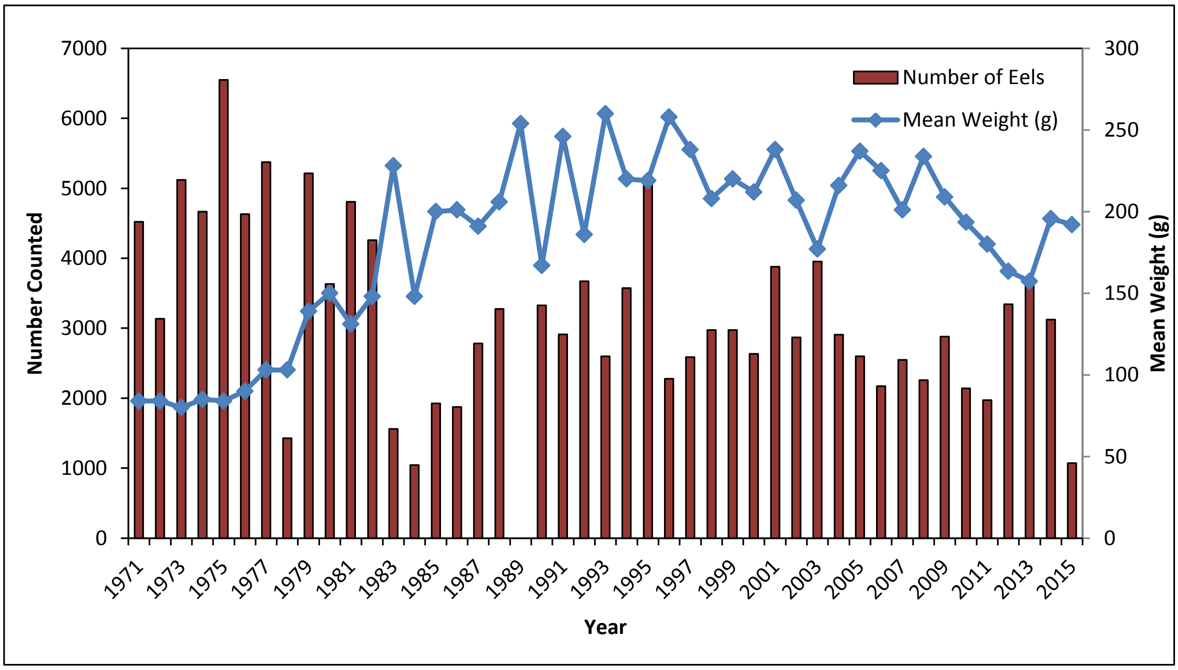


Figure 7-3: Annual number and mean weight of silver eels trapped in the downstream traps.

8 Fishery Report - Catch Data

The Burrishoole Fishery is a valuable part of the overall stock census programme and is run as an integral part of the monitoring programme. As part of the conservation of the Burrishoole wild stock, changes to the active season and to the parts of the catchment being fished have caused differences, or gaps, in the data being collected. Lough Feeagh, which had been closed to angling since 1997 for conservation reasons was opened to angling for the month of September in 2008, on a catch and release basis for wild fish. In 2009 - 2013 Lough Feeagh was open for angling on a catch and release basis from August to the end of September and in 2014 for one week only from 24th August due to low stock. In 2015 Lough Feeagh was open from August 12th to the end of September.

During 2015 Lough Furnace was open to angling from 17th of June to the 30th September. The fishery was operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout.

8.1 Numbers and Average weight of Rod Catch

The Lough Furnace rod catch in 2015 consisted of 9 wild fish and 23 reared fish. The Lough Feeagh rod catch consisted of 19 wild fish and 2 reared fish. All wild caught fish were returned alive.

The average weight of reared fish was 1.8kg (n = 21) and the heaviest fish was 2.6kg. No lengths or weights are available for wild fish due to catch & release being in place.

A total of 24 sea trout were caught on Lough Furnace and 30 sea trout on Lough Feeagh. Regulations remained in place whereby all rod caught sea trout were returned alive.

In addition to the sea trout caught on Lough Feeagh, a total of 502 brown trout were also caught on the lough.

8.2 Timing of Catch and Rod Effort

The highest monthly salmon catch was recorded in July with a catch of 7 wild and 17 ranched salmon. July was also the month of the highest rod effort and overall the rod effort on Lough Furnace decreased 152 rod days in 2014 to 138 in 2015.

The low rod catch of wild fish (9) on Lough Furnace has been attributed to the general high flow rates during the season which resulted in fish running through Lough Furnace rather than staying in the lake. However, this enabled Lough Feeagh to be open for angling longer than the previous year and a rod catch of 19 wild grilse and 2 reared grilse was recorded.

Table 8-1: Wild and reared salmon rod catch and rod effort (hours) for the 2015 season for L. Furnace and L. Feeagh.

Furnace

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	1	1	174.5
July	7	17	659
August	1	5	233.4
September	0	0	39
Total	9	23	1105.9

Feeagh

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	0	0
July	0	0	0
August	11	0	250
September	8	2	175
Total	19	2	425

8.3 Exploitation Rates of Rod Fishery

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2. From 1997 onwards Lough Feeagh was closed to angling. Exploitation rates are only available for Lough Furnace since 1997. The cessation of angling on Lough Feeagh was due to the continuing low stock level of wild fish. Following the cessation of drift netting in 2007 and the increased return of wild fish it was decided to re-open Lough Feeagh in 2008 to angling for the month of September only on a catch and release basis for both wild and ranched fish. Since 2008, and in future years, the running of a fishery on L. Feeagh was reviewed each year and was dependent on sufficient wild stock being present.

No sea trout angling was permitted on L. Feeagh between 1997 and 2008 and since 2008 the fishery has been open on a limited basis. Any sea trout captured were returned alive.

Anglers fishing on Lough Furnace were requested to return wild salmon alive to the water. Injured or damaged wild fish were permitted to be retained; therefore, the rod catch on Lough Furnace consists of a total catch which includes released fish and a retained catch which are fish that have been killed. Sea trout were returned alive.

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2004 to 2015 are shown in Table 8.2.

Table 8-2: Rod fishing exploitation rates (2006-2015). [1] based on total catch; [2] based on catch killed.

	2008	2009	2010	2011	2012	2013	2014	2015
WILD SALMON								
Lough Feeagh								
"Available" fish by end of fishing season	531	585	691	516	683	694	145	632
Total rod catch	18	5	8	13	28	16	0	19
Rod catch retained	0	0	0	0	0	0	0	0
Angling success %[1]	3	0.85	1.15	2.5	4.10	2.31	0.00	3
Exploitation rate %[2]	0	0	0	0	0	0	0	0
WILD SALMON	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Loughs Feeagh & Furnace								
Total stock of wild fish	572	587	703	571	686	734	305	650
+ 10% addition for L. Furnace population	629	646	773	628	755	807	336	715
Total catch of wild fish	52	12	26	36	50	35	8	28
Rod catch retained	1	1	0	0	0	1	0	0
Max. angling success %	9.1	2	3.7	6.3	7.3	4.8	2.6	3.9
Min. exploitation rate	0.2	0.2	0	0	0	0.1	0	0
Max. exploitation rate	0.2	0.2	0	0	0	0.1	0	0
REARED SALMON	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Lough Feeagh								
"Available" fish by end of fishing season	98	115	130	125	128	105	117	101
Total rod catch	1	1	1	1	3	1	0	2
Rod catch retained	0	0	0	0	0	0	0	0
Angling success %[1]	1.0	0.9	0.8	0.8	1.5	1.0	0.0	2
Exploitation rate %[2]	0.0	0	0	0	0	0	0	0
Loughs Feeagh & Furnace								
Total stock	1865	456	940	1293	2392	1301	1205	1931*
Total rod catch	116	7	79	86	78	71	40	25
Exploitation rate %	6.2	1.7	8.4	6.7	3.3	5.5	3.3	1.3
WILD SEA TROUT	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Lough Feeagh								
"Available" fish by end of fishing season	39	135	71	58	129	60	140	58
Rod catch	3	12	1	1	5	12	19	30
Exploitation rate %	0	0	0	0	0	0	0	0
Angling Success %	7.7	8.9	1.4	1.7	3.9	20.0	13.6	51.7

* due to the flooding issue in November & December, this figure is based on the total return of reared fish processed for tags

8.4 Angling Success

Table 8.3 presents the Catch per unit effort (CPUE) which is the number of fish caught per rod day, and the Effort per unit catch (EUPC) which is the number of rod days it takes to catch a fish.

Table 8-3: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery based on a eight hour fishing day. Salmon includes both wild and reared.

	Lough Furnace				Lough Feeagh			
	Salmon		Sea Trout		Salmon		Sea Trout	
Year	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
'80-'84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
'85-'89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
'90-'95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
'96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90
'97	0.17	6.00	0.10	9.60	*	*	*	*
'98	0.44	2.30	0.08	13.20	*	*	*	*
'99	0.09	10.80	0.05	20.80	*	*	*	*
'00	0.30	3.31	0.06	16.50	*	*	*	*
‘01	0.15	6.70	0.12	8.40	*	*	*	*
’02	0.12	8.30	0.07	15.30	*	*	*	*
’03	0.13	7.60	0.06	17.70	*	*	*	*
’04	0.22	4.60	0.16	6.30	*	*	*	*
’05	0.26	3.80	0.08	13.00	*	*	*	*
’06	0.44	2.30	0.04	23.50	*	*	*	*
’07	0.49	2.10	0.14	6.90	*	*	*	*
’08	0.35	2.89	0.05	21.60	0.46	2.18	0.07	13.80
’09	0.18	5.66	0.24	4.09	0.21	4.75	0.42	2.38
’10	0.60	1.66	0.14	7.27	0.82	1.22	0.09	11.00
'11	0.68	1.47	0.35	2.8	1.06	0.95	0.08	13.10
’12	0.96	1.04	0.10	10.10	1.10	0.91	0.18	56.62
'13	0.66	1.51	0.22	4.5	0.60	1.70	0.42	2.40
’14	0.32	3.17	0.35	2.9	0.00	0.00	0.18	5.60
’15	0.23	4.31	0.17	5.75	0.40	2.50	0.56	1.77

9 Collaborative Research Programmes

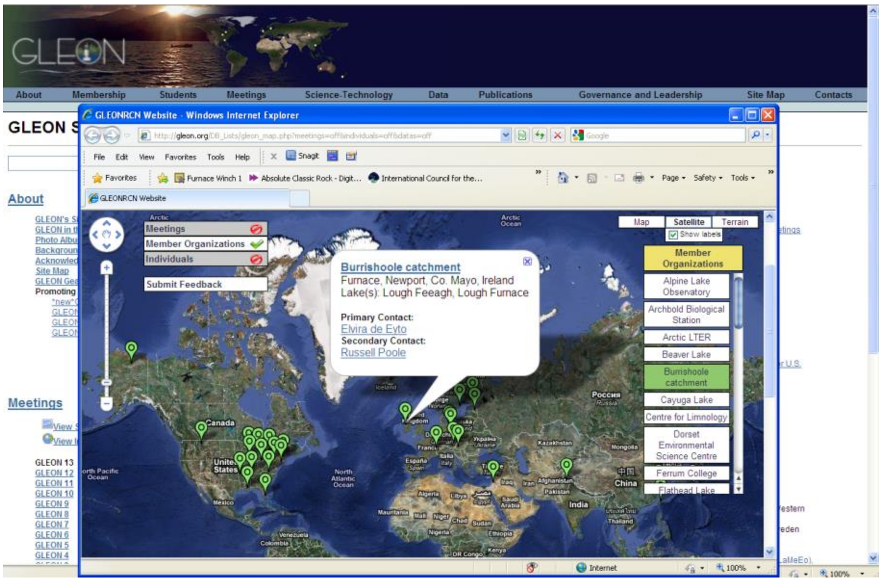
9.1 Alternative life histories (ALH): linking genes to phenotypes to demography

The Institute are collaborating with University College Cork (Dr Tom Reed), who were awarded funding for five years (2014-2019) by the European Research Council (ERC) to achieve an understanding of how genetic, environmental and physiological factors interactively shape ALH tactics in Brown Trout and how this in turn affects population demography.

Understanding how and why individuals develop strikingly different life histories is a major goal in evolutionary biology. It is also a prerequisite for conserving important biodiversity within species and predicting the impacts of environmental change on populations. The aim of this study is to examine a key threshold phenotypic trait (alternative migratory tactics) in a series of large scale laboratory and field experiments, integrating several previously independent perspectives from evolutionary ecology, ecophysiology and genomics, to produce a downstream predictive model. Brown trout *Salmo trutta*, has an extensive history of genetic and experimental work and exhibits 'partial migration': individuals either migrate to sea ('sea trout') or remain in freshwater their whole lives. Recent advances in molecular parentage assignment, quantitative genetics and genomics (next generation sequencing and bioinformatics) will allow unprecedented insight into how alternative life history phenotypes are moulded by the interaction between genes and environment. To provide additional mechanistic understanding of these processes, the balance between metabolic requirements during growth and available extrinsic resources will be investigated as the major physiological driver of migratory behaviour. Together these results will be used to develop a predictive model to explore the consequences of rapid environmental change, accounting for the effects of genetics and environment on phenotype and on population demographics.

9.2 GLEON

In 2007, the Burrishoole catchment became a member of the Global Lake Ecological Observatory Network (GLEON: http://www.gleon.org), an association of limnologists, information technology experts and engineers whose goal is to establish a persistent network of lake ecology observatories (http://www.gleon.org). Work with GLEON working groups continued in 2015, and the Marine Institute was represented at GLEON 17 in Korea by Elvira de Eyto. Data from Lough Feeagh is being used in several GLEON working groups, including those focussed on signal processing of high frequency lake data, the role of catchment processes and dynamics on lake metabolism and the use of HFM to detect deep chlorophyll maximum.



9.3 NETLAKE

The COST-ACTION NETLAKE project continued work in 2015 (www.dkit.ie/netlake). Cost action projects are funded by the EU to provide networking opportunities for scientists in specific research areas. The aim of the NETLAKE action is to build a network of sites and individuals that will support the use of sensor-based systems in lakes and reservoirs and promote the use of these systems to address current and future water quality issues. The Marine Institute (represented by Elvira de Eyto and Russell Poole) are on the management committee of NETLAKE. In 2015, meetings were held in Turkey in January and in Evian des Bains in June. Active areas of work included the continued development of a metadatabase to capture the network of sites in Europe with automatic lake monitors, and production of a set of factsheets detailing high frequency monitoring system deployments.

9.4 Cullen PhD Fellowships

In 2015, a call was put out for four PhD fellowships to be awarded for projects based in Burrishoole. Sean Kelly commenced his project in October 2015; the others will commence in early 2016 and will be reported on fully in the 2017 Annual Report.

The awards were as follows:

Brian Doyle (E. Jennings, DKIT): Resolving the Organic Carbon Budget of a salmonid humic lake.

Sean Kelly (M. White, NUIG): To investigate the dual influence of marine water and freshwater on the hydrography and related ecology of a coastal lagoon, Lough Furnace, Co. Mayo.

Aisling Doogan (D. Brophy, GMIT): Investigation of the causes of early migration mortality in salmon and sea trout from the Burrishoole National Index River using acoustic telemetry in freshwater and coastal areas.

Ross Findley (T. Reed, UCC): Investigation of the early migration of salmon and brown trout from the Burrishoole National Index River using PIT tag technology in freshwater and brackish areas

9.5 Other

The GLTC (Global Lake Temperature Collaboration - www.laketemperature.org) continued to synthesise and analysis lake temperature data from around the world (including from Lough Feeagh), and in 2015, published two important deliverables, O'Reilly et al (2015) and Sharma et al (2015).

During 2015, the catchment team continued collecting samples for inclusion in the GNIR (Global Network of Isotopes in Rivers - http://www-naweb.iaea.org/napc/ih/IHS_resources_gnir.html). GNIR is a global environmental observation programme dedicated to the compilation of isotopic assays of water, nutrients and particulate and dissolved constituents in global river systems. GNIR serves as an essential world-wide repository for riverine isotope data, and facilitates public dissemination of contributed riverine isotopic data through a cost-free user-friendly web portal. GNIR is a complimentary programme to the IAEA (International Atomic Energy Agency) well-established Global Network of Isotopes in Precipitation. Monthly samples are taken from the Black and Mill Race rivers, and dispatched to the IAEA facility in Vienna for analysis.

Finally, the catchment team participated in the CELLDEX project, which was an international project, aimed at studying decomposition rates in small streams across spatial and temporal gradients. Fieldwork was carried out autumn and the results are being processed.

10 Catchment Stock Assessment

10.1 Introduction

The Burrishoole catchment, upstream of the main fish traps, has been monitored since 1990 with surveys of the salmonid and eels stocks taking place in the rivers and the main lakes. Electrofishing, with 3-fishing depletions, is used for salmonids and eels in the streams, fine mesh beach seines are used for salmonids in the lakes and summer fyke nets are used for eels in the lakes. Eel surveys are also undertaken in the tidal waters below the traps.

10.2 Electrofishing Surveys

2015 marked the completion of 25 years of electrofishing surveys in the Burrishoole and Owengarve catchments. Densities of eels and juvenile salmonids were calculated using three pass removal sampling.

In 2015, 38 sites in the Burrishoole and Owengarve catchments were fished between the 3rd September and the 14th October. 2780 fish were caught and measured over the 38 sites. The 38 sites comprised 4658m^2 of representative habitat. Summary data are presented in Figures 10.1-10.6, and these show the distribution of fish densities around the catchment for eel (Fig. 10.1), 0+ salmon (Fig. 10.2), 1+ salmon (Fig. 10.3), 0+ trout (Fig. 10.4), 1+ trout (Fig. 10.5) and 2+ trout (Fig. 10.6).

The average eel density was 0.015 fish/m^2, with eels recorded in 17 sites out of 38. High densities were recorded in the Owengarve and Goulaun Rivers.

Average density of 0+ salmon was 0.22 fish/m^2, with catches recorded in 28 sites. Highest densities were recorded in the Goulaun, Lodge and Rough Rivers. The highest density recorded was 0.9 fish/m^2 which occurred at Goulaun Site 5.

1+ salmon were recorded in 30 sites, with an average density of 0.1 fish/m^2. The Goulaun River generally had high densities of 1+ salmon.

Average densities of 0+, 1+ and 2+ trout were 0.25, 0.10 and 0.02 fish/m^2 respectively. 0+ and 1+ trout were recorded in 37 and 36 sites respectively, while 2+ trout were recorded in 26 sites respectively.

Eel numbers were higher than in 2014, while trout numbers were roughly similar. In Contrast, salmon numbers were down on those recorded in 2014, probably reflecting the very low spawning escapement at the end of 2014 (Fig.10.7) .

10.3 Beach Seine Surveys

Beach seine surveys were conducted in 2015. The data were included in the survey database for future analysis.

10.4 Fyke Net Surveys

10.4.1 Survey Data

Fyke net surveys of yellow eels have been conducted in the 1970s and 1980s as parts of previous studies. The Burrishoole lakes Feeagh and Bunaveela have been incorporated into the National Eel Survey in 2009-2015. Fyke net surveys of the tidal Lough Furnace and 'Back of the House' have been more sporadic or at a lower effort.

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year.

Fyke net surveys carried out between 1960 and 2008 will provide a useful bench mark against which to assess the changes in stock. The yellow eel monitoring strategy will rely on the use of standard fyke nets. Relative density will be established based on catch per unit (scientific-survey) effort.

Bunaveela Lough is located in the upper reaches of the catchment. It has a surface area of 42ha and a maximum depth of 23m. Bunaveela L. was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2015 (7 July 2015), with chains of 10 nets fished at three sites (A, B, C). In total 3 eels were caught with a catch per unit of effort of 0.1 eels/net/night (Table 10.1). The average length was 52.6cm and ranged in length from 46.4cm to 64.1cm. No eels were PIT tagged and no recaptures were made.

Lough Feeagh has a surface area of 395ha and an average depth of 14.5m (with several areas >35m in depth). L. Feeagh was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2015 (22-23 July 2015), with chains of 10 nets fished at six sites (A, C, D, E, F, J) for one night each. In total, 73 eels were caught with a catch per unit effort (CPUE) of 1.22 eels/net/night (Table 10.1). The eels average length was 40.7cm and ranged in length from 30.3cm to 67.5cm, with a total weight of 9.57kgs caught in the two nights. None of the catch was PIT tagged and no previously tagged eel were taken.

Lough Furnace, the tidal lough, has a surface area of 125ha north of Nixon's Island and 16ha between Nixon's Island and the mouth of the estuarine river ('Back of the House'). The main lough has a maximum depth of 21.5m. Furnace is heavily stratified with significant areas of deoxygenated water in the main basin. L. Furnace was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2014 (14-15 July 2015), with chains of 10 nets fished at six sites

(A, B, C, D, E, F) in one night each and one night (30 July 2015) with two chains of nets at the Back of the House which is a shallow tidal area between the lough and the estuarine river.

In L. Furnace, 74 eels were caught with a catch per unit effort (CPUE) of 1.22 eels/net/night (Table 10.1). The eels average length was 40.6cm and ranged in length from 27.4cm to 68.6cm, with a total weight of 9.37kgs caught for the 2 nights (Table 10.1).

In the Back of the House, 61 eels were caught with a catch per unit effort (CPUE) of 3.05 eels/net/night (Table 10.1). The eels average length was 47.2cm and ranged in length from 29.3cm to 84.3cm, with a total weight of 13.04kgs caught.

Table 10-1: Catch details of the standard yellow eel survey carried out in 2015.

Lake	Dates	No. Eels	Net* Nights	CPUE	Total weight (kg)	Mean length (cm)	Mean weight (Kg)
Bunaveela	07/07/2015	3	30	0.10	0.89	52.6 (46.4-64.1)	0.296
	2015	**3**	**30**	**0.10**	**0.89**	**52.6 (46.4-64.1)**	**0.296**
Feeagh	22/07/2015	38	30	1.27	5.17	40.6 (30.3-67.5)	0.136
	23/07/2015	35	30	1.17	4.40	40.9 (32.9-51.8)	0.126
	2015	**73**	**60**	**1.22**	**9.57**	**40.7 (30.3-67.5)**	**0.131**
Furnace	14/07/2015	27	30	0.90	4.23	43.1 (30.7-68.6)	0.157
	15/07/2015	47	30	1.57	5.14	39.1 (27.4-55.1)	0.109
	2015	**74**	**60**	**1.23**	**9.37**	**40.6 (27.4-68.6)**	**0.127**
BOH	30/07/2015	61	20	3.05	13.04	47.2 (29.3-84.3)	0.217
	2015	**61**	**20**	**3.05**	**13.04**	**47.2 (29.3-84.3)**	**0.217**

* Net (pair of traps)

10.4.2 Quantitative Eel Survey

A pilot quantitative eel net survey was commenced in 2015 with sites being selected in Bunaveela (1), Feeagh (2) and Furnace (2). It is intended to fish these again in 2016 and to complete the data analysis for both years together. The aim of the study is to investigate whether eel survey data from fyke nets can be used to predict annual silver eel escapement by comparing the yellow eel data with the silver eel output from the traps. This has relevance to silver eel output modelling (i.e. EDA) for reporting to the EU.

10.4.3 *Anguillicola crassus*

Anguillicola crassus is an indigenous parasitic nematode of the Japanese eel *Anguilla japonica* in Asia. *A. crassus* does not cause serious pathological damage in its natural host. However, infections in European eel are potentially more serious and can cause damage to the swimbladder with associated bacterial damage, red and swollen anus, as well as, in most severe cases, the collapse of the swimbladder lumen.

A. crassus was introduced into Europe in the early 1980s and it has since spread widely and has successfully colonized most European countries. It was first recorded in Ireland (Waterford Harbour) in 1997. Later records came from the Erne catchment in 1998 and it is now present in approximately 74% of the wetted area of Ireland. The most likely infective route to Ireland was the commercial eel trade although localised spread can be through natural eel movements and paratenic hosts.

The Burrishoole catchment remained free of the parasite until recently. In the fyke net survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus.* Samples of yellow eels from L. Feeagh were negative and a comprehensive sample of silver eels from the traps was also negative indicating that in 2012 the infection seemed to be confined to the tidal lough. This was somewhat surprising as a number of environmental factors have been shown to influence *A. crassus* infections. High salinity has been shown as having a negative impact in the egg hatching and larvae survival of the parasite although the effects of water salinity remain unclear as various surveys have shown no differences in infection levels in waters with different salinity values.

Examination of previous samples would indicate that the parasite was likely to have been introduced into L. Furnace in 2010 or early 2011 (Table 10.2).

The infection intensity in L. Furnace eels continued to rise in 2014. To date it has not been recorded in the freshwater catchment above the fish traps, although in 2014 the parasite was found in 57% of yellow eels sampled in the Mill Race upstream from L. Furnace up to the Fish Fence, and in 18% of the eels between the Fish Fence and the outflow from L. Feeagh possibly indicating that upstream migrating eel are likely to carrying the parasite.

10.5 Long-term biological monitoring in the Burrishoole catchment

Macroinvertebrate surveys of 16 index sites were conducted in 2015. 1975 individuals from 48 samples were counted and identified, and are recorded in the Catchment Macroinvertebrate Access database for future analysis. Zooplankton and phytoplankton surveys of Feeagh and Furnace were continued in 2015, with monthly samples being collected using standard methods, and preserved for future enumeration and identification. Zooplankton sample enumeration for Feeagh and Furnace is up to date.

Table 10-2: Location and sample details for eels in Burrishoole examined for the presence of *Anguillicola crassus*.

Year	Location	No. of eels checked	Stage	No. Infected	Prevalence	Intensity
Freshwater						
2009	Traps	50	Silver	0	0	0
2010	Yellow R.	5	Yellow	0	0	0
2010	Black Lakes	3	Yellow	0	0	0
2010	Glenamong R.	3	Yellow	0	0	0
2010	Feeagh	2	Yellow	0	0	0
2010	Traps	17	Silver	0	0	0
2011	Traps	50	Silver	0	0	0
2011	Feeagh	30	Yellow	0	0	0
2012	Feeagh	4	Yellow	0	0	0
2012	Traps	168	Silver	0	0	0
2013	Traps	106	Silver	0	0	0
2014	Traps	94	Silver	0	0	0
2014	Mill Race Lwr	7	Yellow	4	57.1	2.25
2014	Mill Race Uppr	11	Yellow	2	18.2	1.00
2015	Traps	10	Silver	0	0	0
Saline Water						
2008	Furnace	60	Yellow	0	0	0
2009	Fu Nixons	47	Silver	0	0	0
2010	Furnace	10	Yellow	0	0	0
2010	Fu Nixons	50	Silver	0	0	0
2011	Furnace	4	Yellow	2	50	1.0
2012	BOH	6	Yellow	6	100	2.0
2012	Furnace	10	Yellow	7	70	4.4
2013	Furnace	6	Yellow	6	100	13.5
2014	Furnace	9	Yellow	5	56	17.6

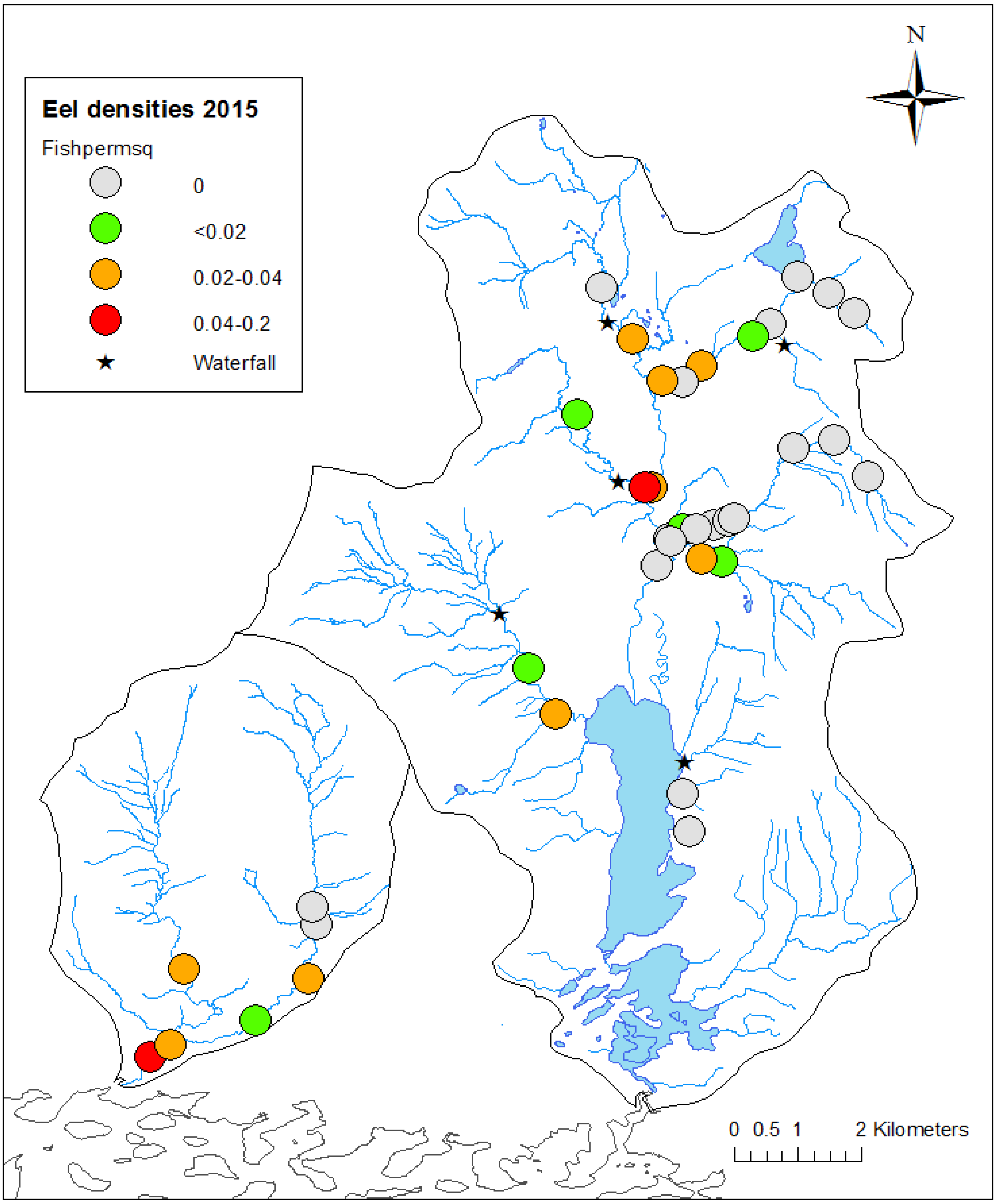


Figure 10-1: Densities of eel calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

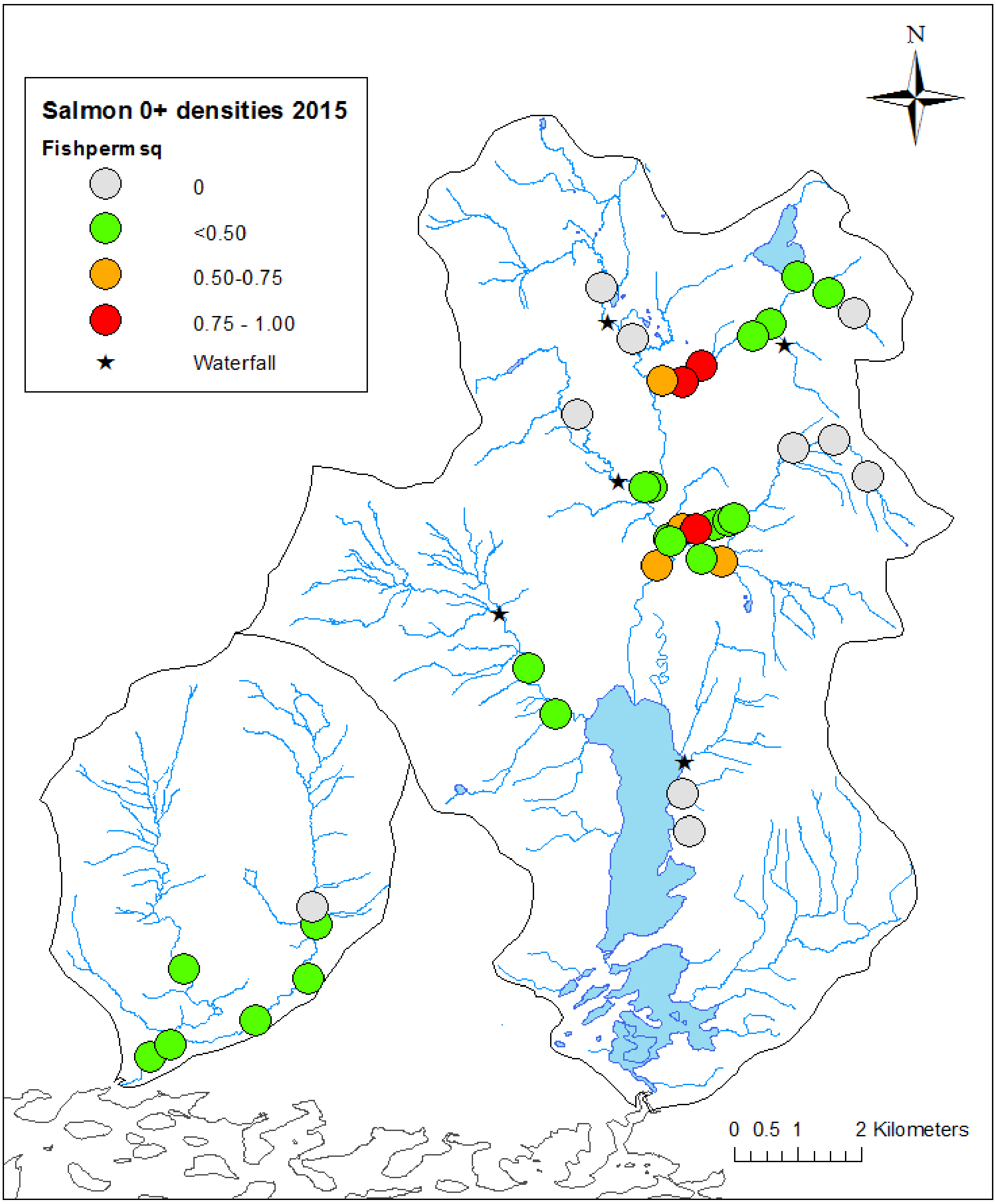


Figure 10-2: Densities of 0+ salmon calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

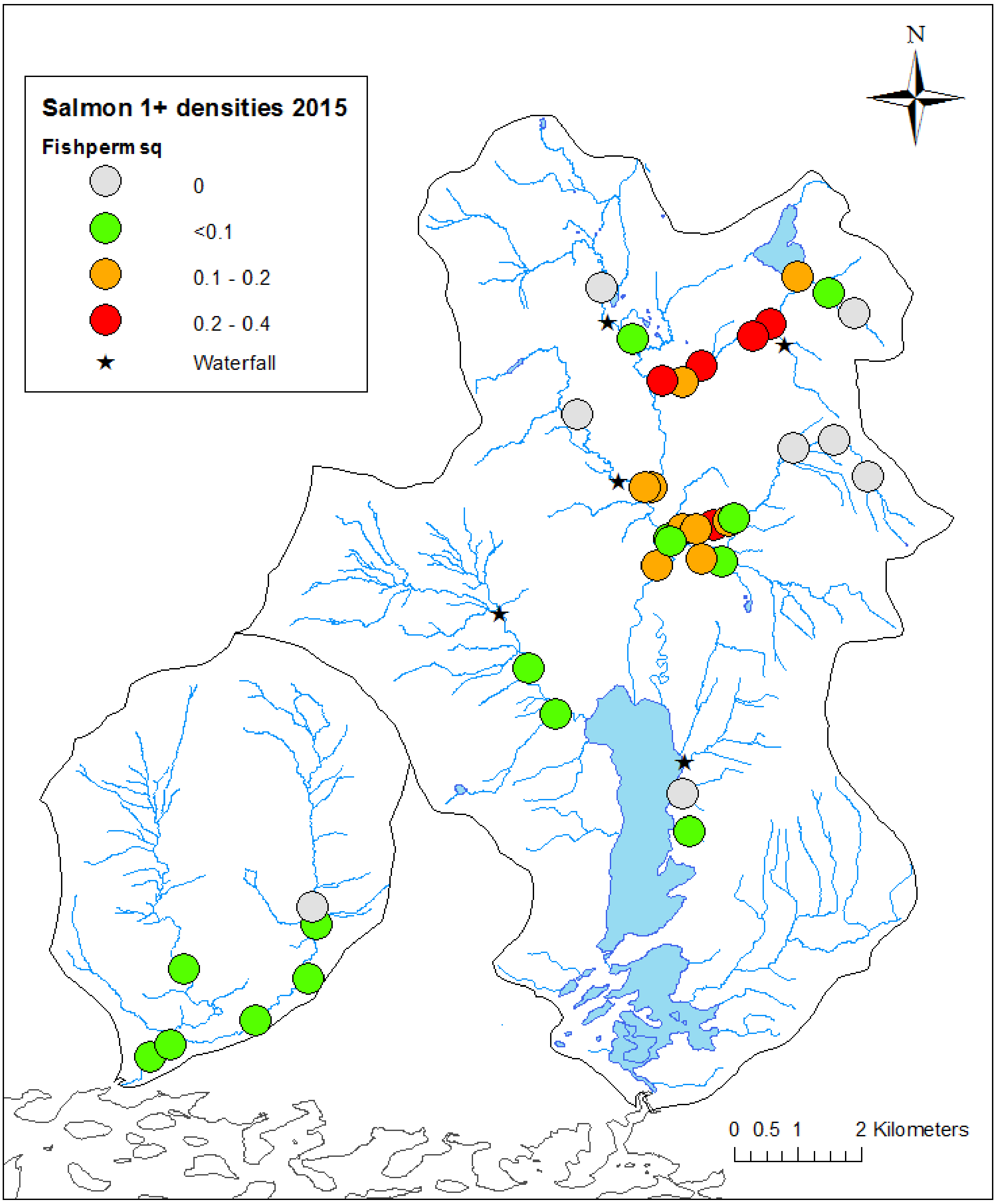


Figure 10-3: Densities of 1+ salmon calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

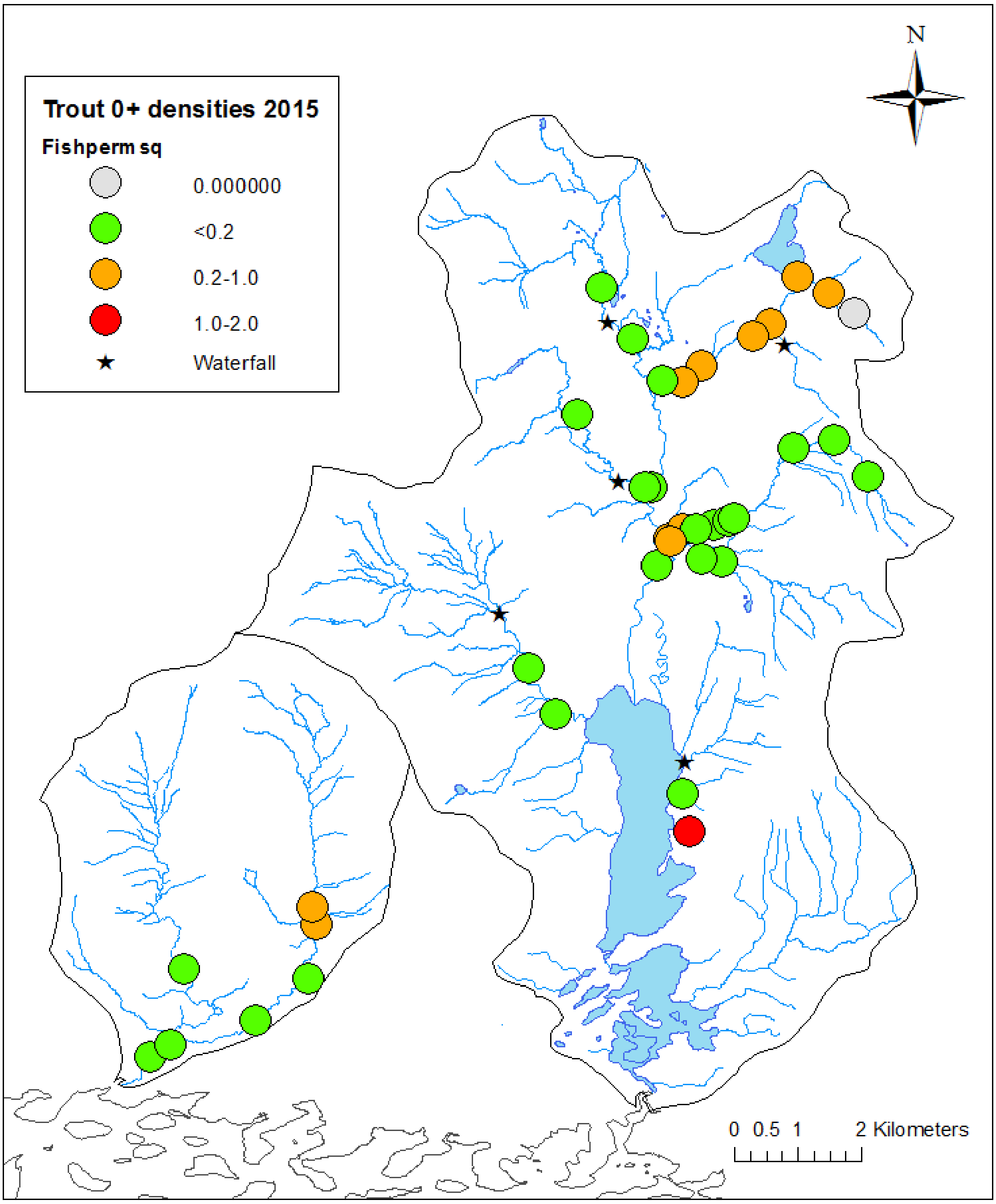


Figure 10-4: Densities of 0+ trout calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

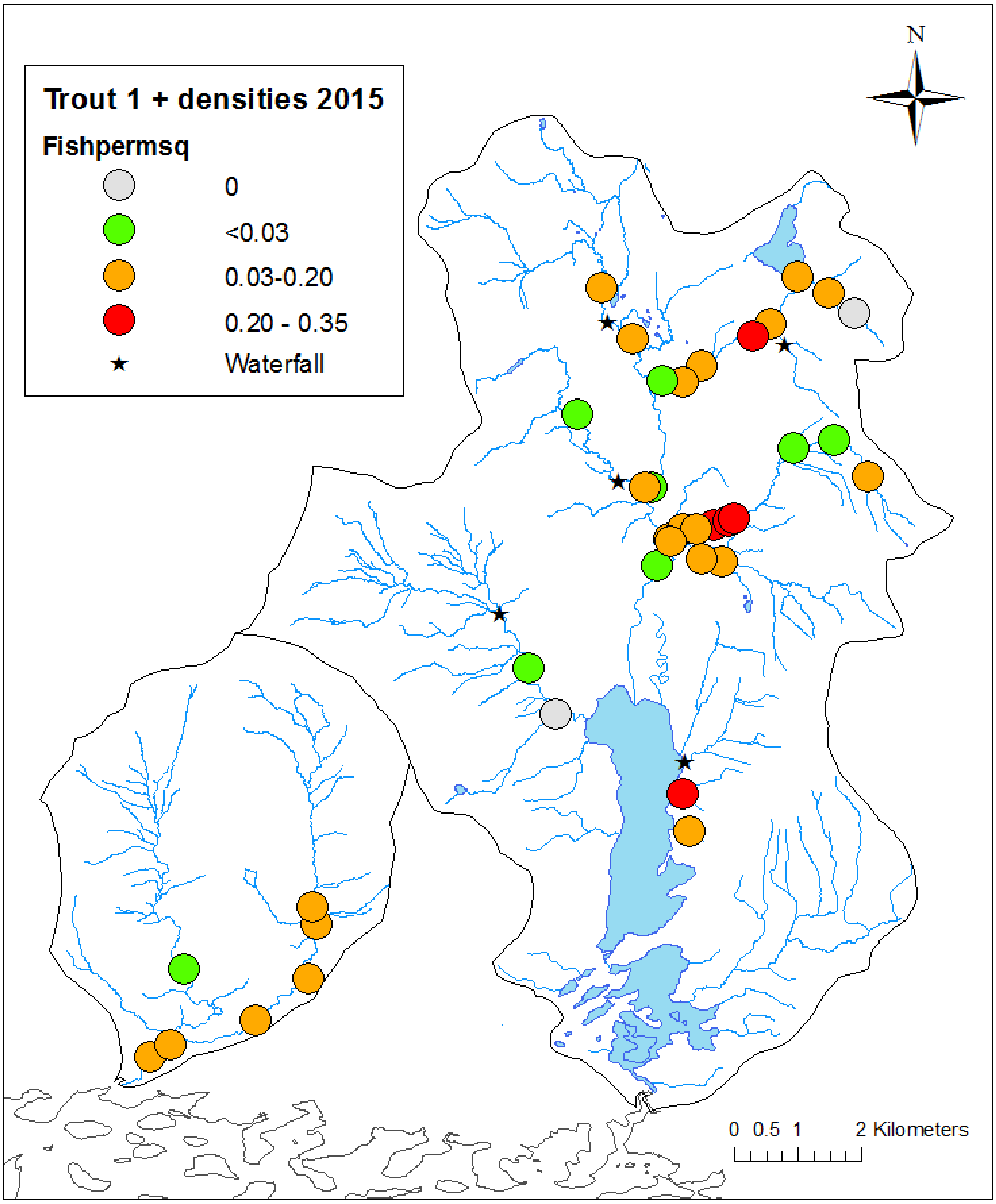


Figure 10-5: Densities of 1+ trout calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

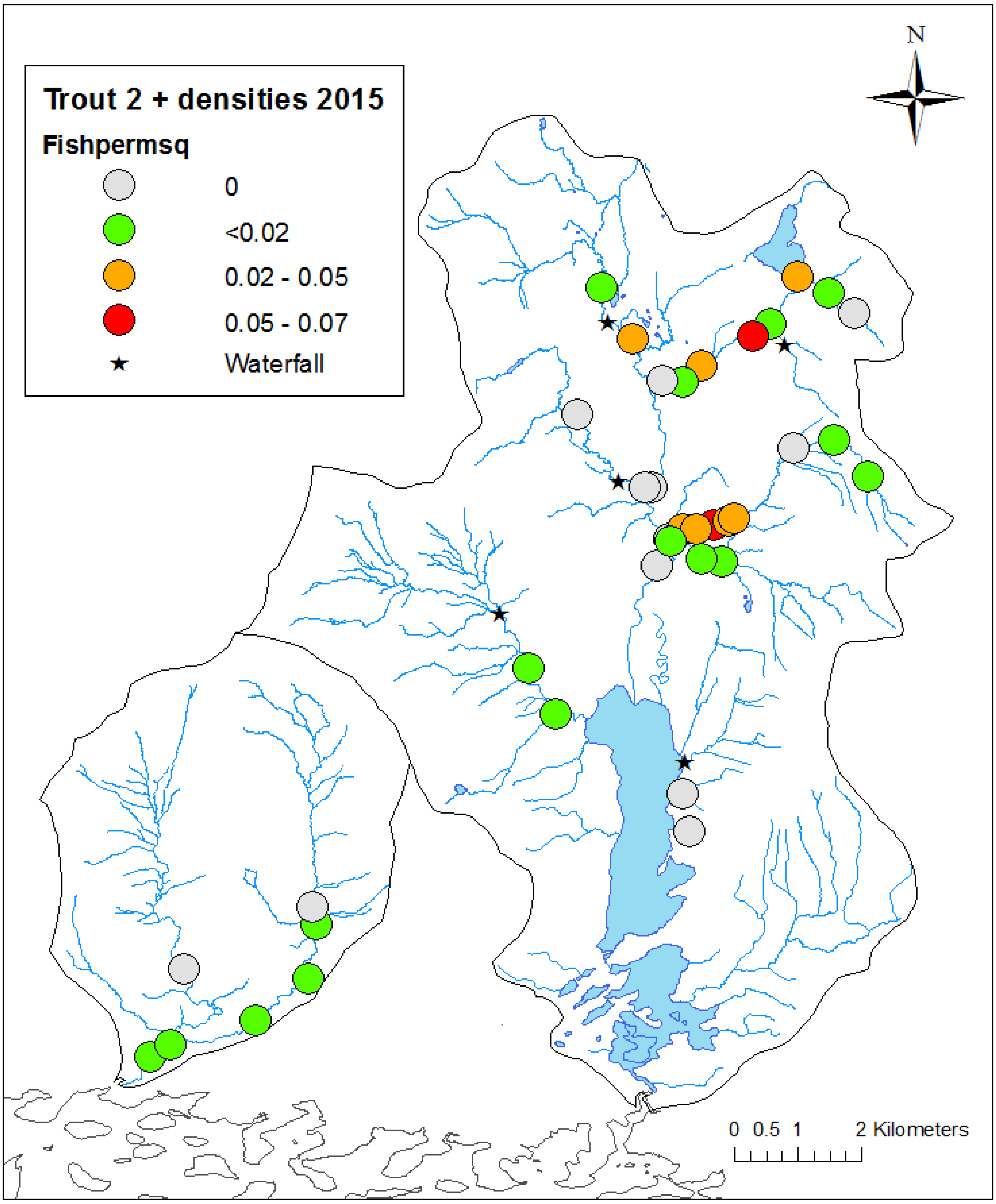


Figure 10-6: Densities of 2+ trout calculated from the 2015 electrofishing survey of the Burrishoole and Owengarve catchments.

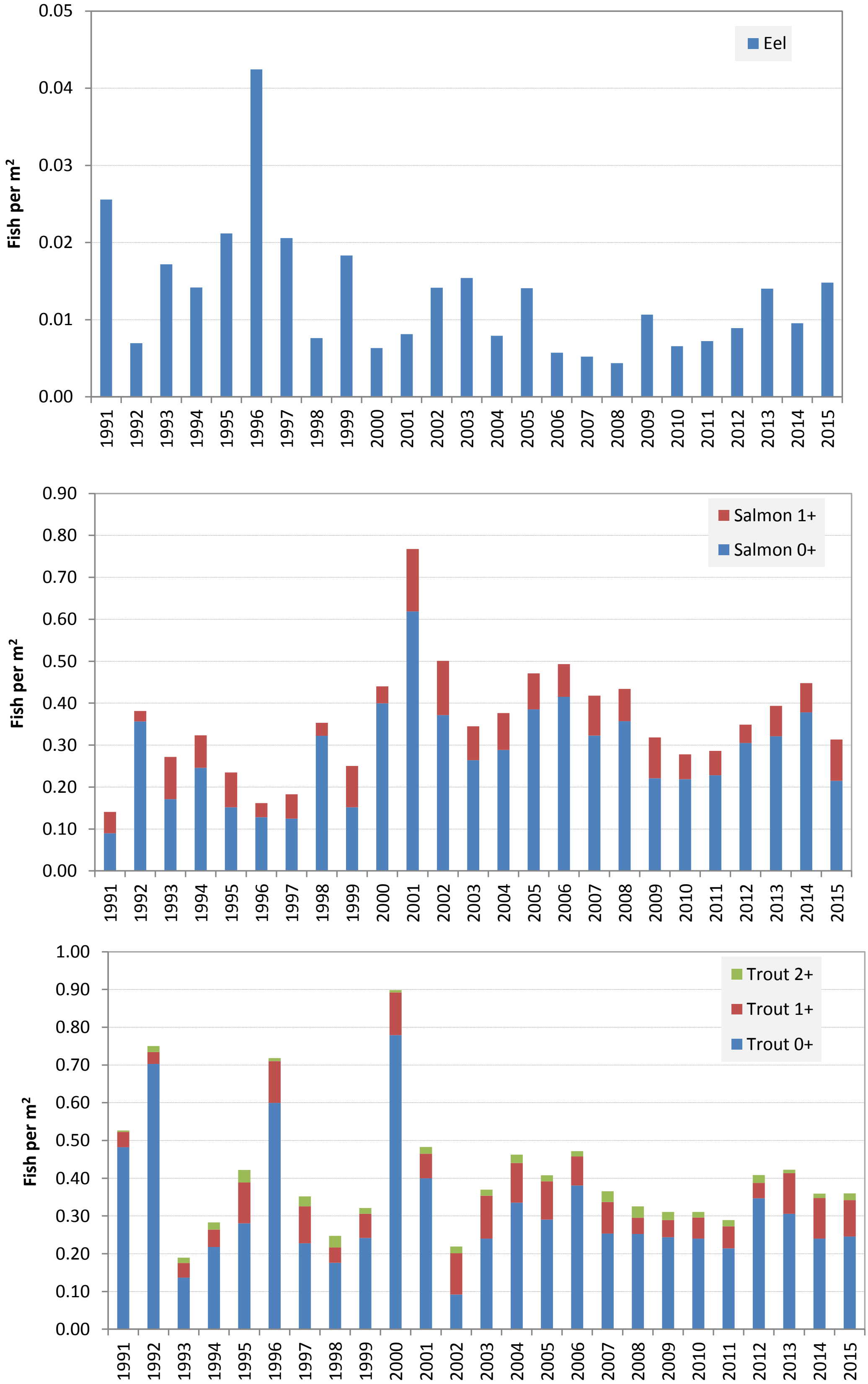


Figure 10-7: Average densities of eel, salmon and trout (fish per m²) calculated from electrofishing surveys of the Burrishoole and Owengarve catchments, 1991-2015.

11 Publications

11.1 Peer-review

de Eyto, E., White, J., Boylan, P., Clarke, B., Cotter, D., Doherty, D., Gargan, P., Kennedy, R., McGinnity, P., O'Maoiléidigh, N., and O'Higgins, K. (2015). The fecundity of wild Irish Atlantic salmon Salmo salar L. and its application for stock assessment purposes. *Fisheries Research* **164**: 159–169. doi:10.1016/j.fishres.2014.11.017.

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Ravinet, M., Hynes, R., Poole, R., Cross, T.F., McGinnity, P., Harrod, C., et al. (2015) Where the lake meets the sea: strong reproductive isolation is associated with adaptive divergence between lake resident and anadromous three-spined sticklebacks. *PLoS ONE* 10(4): e0122825.

Ryder, E., Jennings, E., de Eyto, E., Dillane, M., Nic Aonghusa, C., Pierson, D.C., Moore, K., Rouen, M., and Poole, R. (2015). Reply to a comment by Watras et al. (2014) on temperature compensation method for field measurements of CDOM fluorescence. *Limnol. Oceanogr. Methods* **13**(10): 527–528. doi:10.1002/lom3.10045.

Sharma, S., Gray, D.K., Read, J.S., O'Reilly, C.M., Schneider, P., Qudrat, A., Gries, C., Stefanoff, S., Hampton, S.E., Hook, S., John D Lenters, David M Livingstone, Peter B McIntyre, Rita Adrian, Mathew G Allan, Orlane Anneville, Lauri Arvola, Jay Austin, John Bailey, Jill S Baron, Justin Brookes, Yuwei Chen, Robert Daly, Martin Dokulil, Bo Dong, Kye Ewing, de Eyto, E., David Hamilton, Karl Havens, Shane Haydon, Harald Hetzenauer, Jocelyne Heneberry, Amy L Hetherington, Scott N Higgins, Eric Hixson, Lyubov R Izmest'eva, Benjamin M Jones, Külli Kangur, Peter Kasprzak, Olivier Köster, Benjamin M Kraemer, Michio Kumagai, Esko Kuusisto, George Leshkevich, Linda May, Sally MacIntyre, Dörthe Müller-Navarra, Mikhail Naumenko, Peeter Noges, Tiina Noges, Pius Niederhauser, Ryan P North, Andrew M Paterson, Pierre-Denis Plisnier, Anna Rigosi, Alon Rimmer, Michela Rogora, Lars Rudstam, James A Rusak, Nico Salmaso, Nihar R Samal, Daniel E Schindler, Geoffrey Schladow, Silke R Schmidt, Tracey Schultz, Eugene A Silow, Dietmar Straile, Katrin Teubner, Piet Verburg, Ari Voutilainen, Andrew Watkinson, Gesa A Weyhenmeyer, Craig E Williamson, and Woo, K.H. (2015). A global database of lake surface temperatures collected by in situ and satellite methods from 1985–2009. *Scientific Data* **2**.

Sparber, K., Dalton, C., de Eyto, E., Jennings, E., Lenihan, D. & Cassina, F. (2015). Contrasting pelagic plankton in temperate Irish lakes: the relative contribution of heterotrophic, mixotrophic, and autotrophic components, and the effects of extreme rainfall events. *Inland Waters* **5** (3), 295-310